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NATIONAL DAM SAFETY PROGRAM. EWING DAM (MO 10218), MISSISSIPPI --ETC(U)
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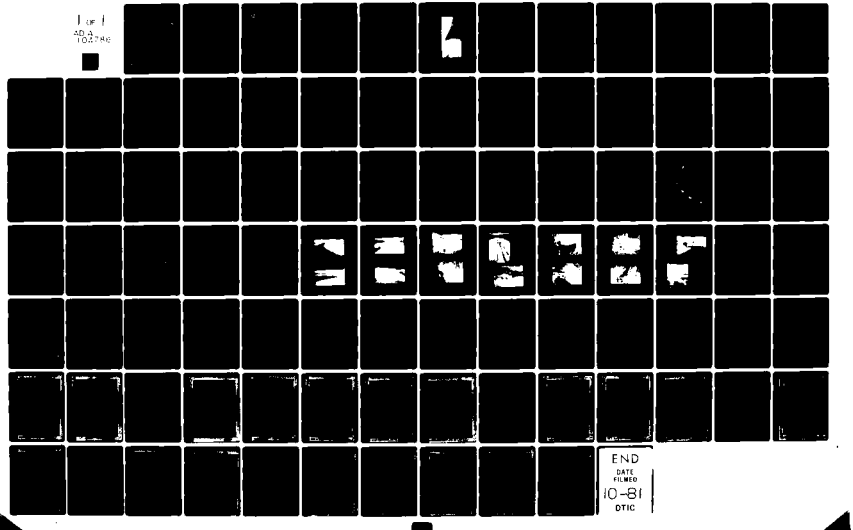


LEVEL II

MISSISSIPPI - SALT-QUINCY RIVER BASIN

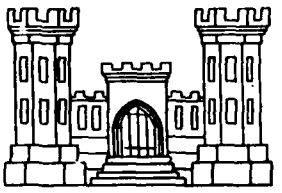
AD A104786

EWING DAM

LEWIS COUNTY, MISSOURI

MO 10218

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

DECEMBER 1978

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Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Ewing Dam (Mo. 10218), Phase I Inspection Report

This report presents the results of field inspection and evaluation of Ewing Dam (Mo. 10218). It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY: SIGNED — 29 DEC 1978
Chief, Engineering Division — (Date)

APPROVED BY: SIGNED — 29 DEC 1978
Colonel, CE, District Engineer — (Date)

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Ewing Dam, Missouri Inv. No. 10218
State Located:	Missouri
County Located:	Lewis
Stream:	Unnamed Tributary of the Middle Fabius River
Date of Inspection:	September 26, and October 6, 1978

Ewing Dam No. Mo. 10218 was inspected using the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U.S. Army, Washington, D.C., with the help of Federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

Based on the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. Three farmhouses with associated farm buildings, one state highway, and one county road would be subjected to flooding with possible damage and/or destruction, and possible loss of life. Ewing Dam is in the intermediate size classification since it is more than 40 feet high, but less than 100 feet high, and impounds more than 1,000 acre-feet but less than 50,000 acre-feet of water.

Our inspection and evaluation indicates that the spillway of Ewing Dam does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Ewing Dam is an intermediate size dam with a high hazard potential required by the guidelines to pass the Probable Maximum Flood without overtopping. It was determined the the spillway will pass 48 percent of the Probable Maximum Flood without overtopping the dam. Our evaluation indicates that the spillway will pass the 100-year flood; that is, a flood having a 1 percent chance of being equalled or exceeded during any given year.

The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region.

Other deficiencies noted by the inspection team were a need for an annual inspection by a qualified professional engineer; lack of a maintenance schedule; a surface erosion gully at the right abutment contact; a clogged service spillway intake; and an unprotected emergency spillway crest. The lack of stability and seepage analysis on record is also a deficiency that should be corrected.

It is recommended that the owner take action to correct or control the deficiencies described above.

EWING DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Ewing Dam, I.D. No. 10218

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NATIONAL DAM SAFETY PROGRAM

EWING DAM, Missouri Inv. No. 10218

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for the Ewing Dam was carried out under Contract DACW 43-78-C-0160 to the Department of the Army, St. Louis District, Corps of Engineers, by the engineering firms of Consoer, Townsend & Associated Ltd., and Engineering Consultants, Inc. (A Joint Venture), of St. Louis, Missouri.

b. Purpose of Inspection

The visual inspection of the Ewing Dam was made on September 26 and October 6, 1978. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project; presents a summary of visual observations made during the field inspection; presents an evaluation of hydrologic and hydraulic conditions at the site; presents an evaluation as to the structural adequacy of the various project features; and assesses the general condition of the dam with respect to safety.

It should be noted that reference in this report to left or right abutments is as viewed looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to north abutment or side, and right to the south abutment or side.

d. Evaluation Criteria

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams", Appendix D. These guidelines were developed with the help of several Federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 Description of the Project

a. Description of Dam and Appurtenances

The dam embankment is a homogeneous earthfill structure. The crest of the embankment has a width of 16 feet and a length of approximately 595 feet. The crest elevation is set at 598.0 feet above MSL, and the maximum height of the embankment is 41 feet above the minimum streambed elevation.

The upstream slope of the embankment section is constructed with a 1V to 2-1/2H slope for the top 8 vertical feet, a 10-foot wide berm at elevation 590.0, and a 1V to 2-1/2H slope to the ground surface. The downstream embankment slope is 1V to 2-1/2H from the crest to the toe. No riprap was provide for slope protection on the upstream face of the dam.

Bedrock within the vicinity is composed of Mississippian age limestones and shales. No rock crops out over the site. Soils in the region are predominantly glacial or mixed glacial-loessial. The soils in the vicinity of Ewing Dam are likely Lindley silt loams.

A cut-off trench, with side slopes of 1V to 2H, and a base width of 20 feet, was excavated through the foundation materials in the channel section of the dam and into firm clays or bedrock through the abutments.

The service spillway of the Ewing Reservoir consists of a 10-foot deep, 30-inch diameter vertical steel pipe which connects to a 12-inch diameter steel pipe with an invert elevation at 590 MSL, and exits at the downstream toe of the embankment at elevation 558 MSL near the pump house.

The intake of the 30-inch diameter pipe is protected by a 5'-5" x 3'-3" trashrack which is made of 1/2" diameter reinforcing bars with spacing between bars at 6 inches. The 12-inch diameter pipe discharges into a small pond near the pump house before entering into the natural channel.

The emergency spillway is a cut section near the left abutment. The spillway crest shape is trapezoidal with crest length of 80 feet and side slopes of 1V to 3H. The spillway crest is at elevation 594.0 feet MSL. The entire spillway is an unlined open channel. The channel width narrows from 80 feet at the crest to about 50 feet near the downstream toe of the dam before entering the downstream channel. The spillway channel is parallel to and at the downstream side of the service road.

A municipal water treatment plant for the town of Ewing lies at the toe of the dam to the left side of the pool formed at the pipe outlet of the service spillway. The settling basin overflow and backwash water drains from the plant discharge into the pool.

The treatment plant provides for chemical treatment, settling, and filtering of the water supply. Pumps deliver the water through a pipeline into storage facilities at Ewing. Raw water from the reservoir is fed into the plant by gravity flow.

The raw waterline consists of an 8-inch diameter ductile iron pipe under the dam embankment which connects at its upstream end with a 6-inch diameter flexible hose fitted with an intake strainer. The strainer is suspended by a galvanized wire rope connected to a hand hoist which is mounted upon a floating platform. The degree of submergence

of the intake strainer can be adjusted by the hoist. The floating platform is attached to two lightweight structural steel beams, each 50-feet in length, which are anchored to the dam embankment. A pedestrian walk to the platform is provided by wooden boards bolted to the beams.

The design drawings indicate a tripod tower for support of the intake strainer in lieu of the floating platform. Evidently the tripod structure was either demolished or not constructed.

Slopes of the reservoir shore is gentle and well-defined with wooded reservoir concentrated at the higher elevations along the reservoir rim.

b. Location

The Ewing Dam is located on an unnamed tributary of the Middle Fabius River, Lewis County, Missouri. The nearest community downstream of the lake is Ewing, Missouri, which is about one mile from the dam. The dam and reservoir is shown on Monticello Quadrangle Sheet (7.5 minute series) in Section 6, Township 60 North, Range 7 West.

c. Size Classification

According to the "Recommended Guidelines for Safety Inspection of Dams", by the U.S. Department of the Army, Office of the Chief Engineer, the dam is classified in the dam size category as being "Small" since its storage is less than 1,000 acre-feet. The dam is also classified as "Intermediate" in dam size category because its height is more than 40 feet. The overall size classification is governed by the larger of these two determinations and, accordingly, the dam is classified as "Intermediate" in size.

d. Hazard Classification

The dam has been classified as having "High" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. Our findings concur with the classification. The estimated damage zone extends two miles downstream of the dam. Within the first mile downstream of the dam are three farmhouses with associated farm buildings, one state highway, and one county road. The floodplain is farmed.

e. Ownership

Ewing Dam is owned by the City of Ewing, Lewis County, Missouri 63440, c/o Ewing Water Superintendent.

f. Purpose of Dam

The purpose of the dam is to impound water for use in a water supply system operated by the City of Ewing. The impounded water is released by means of the bottom outlet for subsequent use in the city by way of a pumping station immediately downstream from the dam.

g. Design and Construction History

Ewing Dam was designed in 1967 by Groner & Picker Consulting Engineer & Land Surveyors of Jefferson City, Missouri. The construction was completed in late 1967 by Mertins Construction Company of Kingdom City, Missouri. The water plant, located below the dam, was built by Jack Donaldson Construction Company.

h. Normal Operational Procedures

The dam is used to impound water for use as water supply for the City of Ewing, Missouri. The reservoir level is controlled by rainfall, runoff, evaporation, and the water requirements of the City of Ewing, Missouri. The reservoir is likely close to full at all times.

1.3 Pertinent Data

a. Drainage Area — 655 acres

b. Discharge at Damsite — All discharges at the site are through 2 uncontrolled spillways and a water supply outlet

Estimated experienced maximum flood:	700 cfs
Estimated ungated spillway capacity at maximum pool elevation:	2,400 cfs (U/S W.S. at 598)

c. Elevation (Feet above MSL)

Top of dam:	598.0
Spillway crest: (Service spillway)	590.0
(Emergency spillway)	594.0
Minimum streambed elevation at centerline of dam:	557.0
Maximum tailwater:	Unknown

d. Reservoir

Length of maximum pool:	2,700 feet ±

e. Storage (Acre-Feet)

Top of dam:	881
Spillway crest : (Emergency spillway)	653

f. Reservoir Surface (Acres)

Top of dam:	65
Spillway crest: (Service spillway)	45

g. Dam

Type:	Earth embankment
Length:	595 feet
Height (maximum):	41 feet
Top width:	16 feet
Side slopes:	
Downstream	1V to 2-1/2H
Upstream	1V to 2-1/2H
Zoning:	None
Impervious core:	None
Cutoff:	Core trench with 20-foot bottom width and 1V to 2H side slopes
Grout curtain:	None

h. Diversion and Regulating Tunnel None

i. Spillway

Type:	(Service spillway)	Uncontrolled
	(Emergency spillway)	Uncontrolled
Length of weir:	(Service spillway)	30-inch diameter intake
	(Emergency spillway)	80 feet wide
Crest Elevation:	(Service spillway)	590.0
	(Emergency spillway)	594.0

j. Regulating Outlets

Type:	8-inch diameter ductile iron pipe
Length:	300 feet
Closure:	8-inch diameter ductile iron pipe in treatment plant
Maximum Capacity:	2.6 cfs

SECTION 2: ENGINEERING DATA

2.1 Design

Original design drawings are available for the dam and appurtenant structures. These drawings were made in 1967, and are given as plates in this report.

2.2 Construction

No additional construction data is available. There has been no reconstruction done on the dam or appurtenant structures. The dam was constructed in 1967.

2.3 Operation

No operation records for Ewing Dam are available.

2.4 Evaluation

a. Availability

The only engineering data available is the original design drawings. No construction data or operation data is available.

No pertinent data was available for review on hydrology, spillway capacity, flood routing through the reservoir, outlet capacity, slope stability, or seepage analysis.

b. Adequacy

The design drawings available are adequate to aid in evaluating the adequacy of the hydraulic and hydrologic capabilities and stability of the dam for Phase I investigations.

The lack of engineering data other than design drawings did not allow for a definitive review and evaluation. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing and evaluating design, operation and construction data, but is based primarily on visual inspection with the aid of the available design drawings, past performance history and sound engineering judgment.

Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity

The dam and appurtenant structure appeared to be constructed in accordance with the design drawings, with the exception of the intake structure used for supporting the strainer.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

A visual inspection of Ewing Dam was made on September 26, and October 6, 1978. The following persons were present during the inspection:

Name	Affiliation	Discipline
Yin Au-Yeung	Engineering Consultants, Inc.	Project Engineer, Hydraulics and Hydrology
David Bramwell	Engineering Consultants, Inc.	Geology
Jon Diebel	Engineering Consultants, Inc.	Soils
John Ismert	Engineering Consultants, Inc.	Mechanical
Kevin Blume	Consoer, Townsend & Assoc., Ltd.	Civil & Structural

Specific observations are discussed below.

b. Dam

The crest of the dam is provided with a good road base material. The road base, composed of 3/4-inch gravel aggregate, extends for a width of 10 feet, with cut grass lying on either side of the road base for the 16-foot width of the crest.

The upstream embankment slope contains no riprap, and is only protected by heavy vegetation. Some sloughing is occurring on the slope near the high water mark, but the condition is not serious at this time.

The downstream embankment slope has a very good vegetative cover. Erosion is not prevalent on the slope, however, a surface erosion gully is forming at the right abutment contact. The drainage path is currently 2 feet wide by 2 feet deep, and is caused mostly by surface drainage from the hillside and along the approach road. Some rodent activity was noted on the upstream and downstream embankment slopes.

No data is available indicating the material used for construction of the embankment. Visual inspection of the material showed it to be fairly high plastic clay with 10 to 20% sand. The material would be classified as CL-CH by the Unified Soil Classification System.

No seepage was observed on the downstream embankment slope or downstream of the toe of the dam. Also, no signs of present or past instability were seen on the embankment or in the foundation at any location.

c. Appurtenant Structures

(1) Spillway

The 30-inch diameter steel inlet pipe of the service spillway is protected by a rectangular shape trashrack which is made of 1/2-inch diameter reinforcing bars. Both the steel pipe and the trashrack are in good condition. However, the entire upstream embankment slope is covered with heavy vegetation, particularly at the spillway intake. At the time of inspection, over one-third of the trashrack opening was clogged with thick vegetative growth and debris. This thick vegetation at the spillway intake would obstruct water from entering

the inlet pipe and would reduce the spillway discharge capacity. The 12-inch diameter discharge pipe is in good condition. No noticeable leakage or structural distress was observed on the entire spillway structure.

The crest of the emergency spillway is an unlined earth section which contains no riprap or grass protection. Moderate erosion was noted on the spillway crest. The erosion on the crest was caused mainly by frequent vehicular traffic over the area. Some vegetative growth was observed on the upstream side of the spillway crest. The spillway discharge channel downstream from the crest is well-defined and adequately maintained. No signs of erosion or sloughing were apparent on the channel at any point.

(2) Outlet Works

The floating platform, access walkway, steel beams, anchorage fitting in the embankment, and hoist on the platform were observed. A cursory inspection of the water treatment plant was made and discharge of the raw water supply line into the settling basin were observed. During the inspection, the overflow drain from the settling basin operating and discharged into the spillway outlet pool.

The size, material, and conditon of the raw water outlet pipe under the dam could not be confirmed since it is buried and not accessible for inspection.

d. Reservoir Area

The water level was at elevation 589.0 at the time of the inspection.

In general, up to a point about 10 feet above the lake level, the lake rim is fairly flat and gentle, and then it slopes upward more sharply. No signs of instability of the terrain around the lake are readily apparent. The lake shore area is covered by trees and is undeveloped. The reservoir shore is in the natural state and not protected against shoreline erosion.

e. Downstream Channel

The immediate downstream channel is well-defined with sharply sloping banks on the right bank and approximately 1V to 1H slopes on the left bank. The channel bottom width is about 20 feet. Some aquatic growth was noted in the downstream channel, but this was not considered to affect the hydraulic ability of the channel to convey the spillway discharges.

3.2 Evaluation

The visual inspection did not demonstrate any items which are significant enough to indicate a need for immediate remedial action.

The following minor problems were observed which indicate the need for remedial measures within a reasonable period of time.

1. The erosion path at the right abutment contact, caused by surface drainage.

2. The obstructed intake of the service spillway.

3. Unprotected crest of the emergency spillway.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

Ewing Dam is used to impound water from an unnamed tributary of the Middle Fabius River for use as water supply for the City of Ewing, Missouri. The water treatment plant is located just downstream of the dam, and is visited daily by the water superintendent.

The only operating facility at the damsite is raw water supply intake and appurtentant piping connected with the treatment plant, which operates automatically.

4.2 Maintenance of Dam

The dam is maintained by the Ewing Water Superintendent. Items observed at the dam requiring maintenance include repairs to the erosion gully at the right abutment contact, clearing vegetation near the service spillway intake, and planting grass on the emergency spillway crest.

4.3 Maintenance of Operating Facilities

The only operating facility at the damsite is the raw water supply system, which operates essentially unattended. Inspection of the system did not reveal any problems requiring maintenance.

4.4 Description of Any Warning System in Effect

The inspection team is not aware of any existing warning system for this dam.

4.5 Evaluation

The operation procedures and maintenance program appears to be satisfactory at the damsite. The erosion gullies and the vegetation near the service spillway intake should be repaired in the near future.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design

Ewing Dam has a watershed area of approximately 655 acres, of which approximately one-half is covered by woodlands and forest. Land gradients in the higher elevations of the watershed range from 2.5 to 3 percent, and roughly 3 to 4 percent for the area surrounding the lake. Ewing Dam is located on an unnamed tributary of the Middle Fabius River.

Elevations within the watershed range from approximately 590 feet above MSL at the damsite to over 690 feet above MSL in the upper portion of the watershed.

A drainage map showing the watershed area is included in Appendix B.

Evaluation of the hydraulic and hydrologic features of Ewing Dam was based on criteria set forth in the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams, and additional guidance provided by the St. Louis District of the Corps of Engineers. The Probable Maximum Flood (PMF) was calculated from the Probable Maximum Precipitation (PMP) using the methods outlined in the U.S. Weather Bureau Publication, Hydrometeorological Report No. 33. The probable maximum storm duration was set at 24 hours, and storm rainfall distribution was based on criteria given in EM 1110-2-1411 (Standard Project Storm). The SCS triangular hydrograph, transformed to a curvilinear hydrograph, was

adopted for developing the unit hydrograph. The derived unit hydrograph is presented in Appendix B.

The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region.

Initial and infiltration loss rates were applied to the PMP to obtain rainfall excesses. The rainfall excesses were then applied to the unit hydrograph to obtain the PMF hydrograph, utilizing the Corps of Engineers' computer program HEC-1, (Dam Safety Version), which was prepared specifically for dam safety analysis. The computed peak discharge of the PMF and one-half of the PMF are 11,738 cfs and 5,869 cfs, respectively.

Both the PMF and one-half of the PMF inflow hydrographs were routed through the reservoir by the Modified Puls Method, also utilizing the HEC-1 (Dam Safety Version) computer program. The peak outflow discharges for the PMF and one-half of the PMF are 7,722 cfs and 2,560 cfs, respectively. Both the PMF and one-half of the PMF, when routed through the reservoir, resulted in overtopping of the dam. The spillway for Ewing Dam is capable of passing a flood equal to 48 percent of the PMF without overtopping of the dam. The PMF will overtop the dam by 1.80 feet.

The stage-outflow relation for the spillways were prepared from field notes, sketches and limited construction drawings. The reservoir stage-capacity data were based on the U.S.G.S. quadrangle topographic maps in combination with data given in the National Dam Safety Inventory Table. Reservoir storage capacity included surcharge levels exceeding the top

of the dam, and the spillways and overtop rating curve assumed that the dam remains intact during routing. In the routing computations, the discharge through the outlet facilities was excluded due to its insignificant magnitude as compared to the spillways discharge and the PMF. The combined spillways and overtop rating curve and the reservoir capacity curve are also presented in Appendix B.

From the standpoint of dam safety, the hydrologic design of a dam aims at avoiding overtopping. Overtopping is especially dangerous for an earth dam because the downrush of waters over the crest will erode the dam face and, if continued long enough, will breach the dam embankment and release all the stored water suddenly into the downstream floodplain. The safe hydrologic design of a dam calls for a spillway discharge capability, in combination with an embankment crest height that can handle a very large and exceedingly rare flood without overtopping.

The Corps of Engineers designs its dams to safely pass the Probable Maximum Flood that is estimated could be generated from the upstream watershed. This is the generally accepted criterion for major dams throughout the world, and is the standard for dam safety where overtopping would pose any threat to human life. Although dams that do not fully meet this standard will not be evaluated as "unsafe", the Corps considers the <u>minimum</u> hydrologic requirement for safety for this dam to be the capability to pass the Probable Maximum Flood without overtopping.

b. Experience Data

No records of reservoir stage or spillway discharge are maintained for this site. However, according to the owner, the maximum reservoir level was never higher than the crest of the dam.

c. Visual Observations

The service spillway, emergency spillway and the exit channel are in good structural condition. However, in order to maintain an adequate hydraulic condition for these spillways, the heavy vegetative growth on the upstream embankment slope should be cleaned off regularly and the erosion occurring on the emergency spillway crest should be controlled. Spillway releases from both spillway are away from the abutment and, therefore, will not endanger the integrity of the dam.

d. Overtopping Potential

As indicated in Section 5.1-a., both the Probable Maximum Flood and one-half of the Probable Maximum Flood, when routed through the reservoir, resulted in overtopping of the dam. The PMF and one-half of the PMF overtopped the dam crest by 1.80 feet and 0.08 feet, respectively. The total duration of embankment overflow for the PMF is 1.75 hours. The spillways of Ewing Dam are capable of passing a flood equal to approximately 48 percent of the PMF just before overtopping the dam. The 100-year flood is approximately equal to 14 percent of the PMF and, therefore, the spillway is capable of passing the 100-year flood without overtopping of the dam. Since of the PMF is the Spillway Design Flood (SDF) for Ewing Dam, according the the Recommended Guidelines for Safety

Inspection of Dams by the Corps, the spillway capacity of the dam is considered "Inadequate".

The effect from rupture of the dam could extend approximately two miles downstream of the dam. Within the first mile downstream of the dam are three farmhouses with associated farm buildings, one state highway, and one county road. The floodplain is farmed.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

There were no signs of settlement or distress observed on the embankment or foundation during the visual inspection. The upstream slope, crest, and downstream slope are generally well protected by riprap, road base material, or vegetation. The surface erosion path at the right abutment contact should bew repaired in a reasonable period of time.

Both the service spillway and emergency spillway are well-defined, but not adequately maintained. However, there were no signs of leakage or structural distress observed on the spillways. No signs of slope instability or sloughing were noticed in the emergency spillway.

No problems were observed with the water supply intake and piping which will jeopardize the safety of the dam.

b. Design and Construction Data

No design or construction data relating to the structural stability of the dam were found. No design data relating to seepage and stability analysis are known to exist.

c. Operating Records

No operating records are available relating to the stability of the dam or appurtenant structures. Water levels have not been recorded, but the level was within 1 foot of being full on the day of inspection, and is assumed to be close to full at all times. Discharges from the water treatment plant into the pond downstream of the dam are assumed to occur regularly, depending on the amount of water being treated.

d. Post Construction Changes

No post construction changes exist which will affect the structural stability of the dam or appurtenant structures.

e. Seismic Stability

In general, projects located in Seismic Zones 0, 1 and 2 may be assumed to present no hazard from earthquake, provided the static stability conditions are satisfactory and conventional safety margins exist. Ewing Dam is located in Seismic Zone 1. A detailed seismic analysis is not felt to be necessary for this embankment.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team.

It is also important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that an unsafe condition could be detected.

a. Safety

The spillway capacity has been found to be "Inadequate" to safely pass the PMF.

Several other items were observed during the visual inspection which should be repaired within a reasonable period of time. These items include:

1. The erosion path at the right abutment contact caused by the surface drainage.

2. The obstructed intake of the service spillway.

3. Unprotected crest of the emergency spillway.

b. Adequacy of Information

Information concerning operation and maintenance of the dam and appurtenant structures is somewhat lacking. It is recommended that the following programs be initiated to help alleviate this problem:

1. Annual inspection of the dam by a professional engineer experienced in the design and construction of earthen dams should be made and this inspection report made a matter of record.

2. Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.

3. Perform seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams".

The design drawings, together with performance history and visual inspection findings is felt to be adequate information to support the conclusions presented in this report.

c. Urgency

The remedial actions recommended in Section 7.2 should be accomplished within a reasonable period of time.

d. Necessity for Phase II Inspection

Based on results of the Phase I inspection, a Phase II inspection is not felt to be necessary.

7.2 Remedial Measures

The following remedial measures should be undertaken within a reasonable period of time:

1. Increase the spillway capacity to safely pass the Probable Maximum Flood.

2. Repair the surface erosion gully at the right abutment contact by compacting material into the gully, and prevent future problems by regrading the crest to prevent waters from flowing along the roadway and down the abutment contact.

3. Clear the service spillway intake of obstructions, and prevent future clogging by removing large vegetation from the nearby area.

4. Plant native grasses on the crest of the emergency spillway to prevent erosion during discharges.

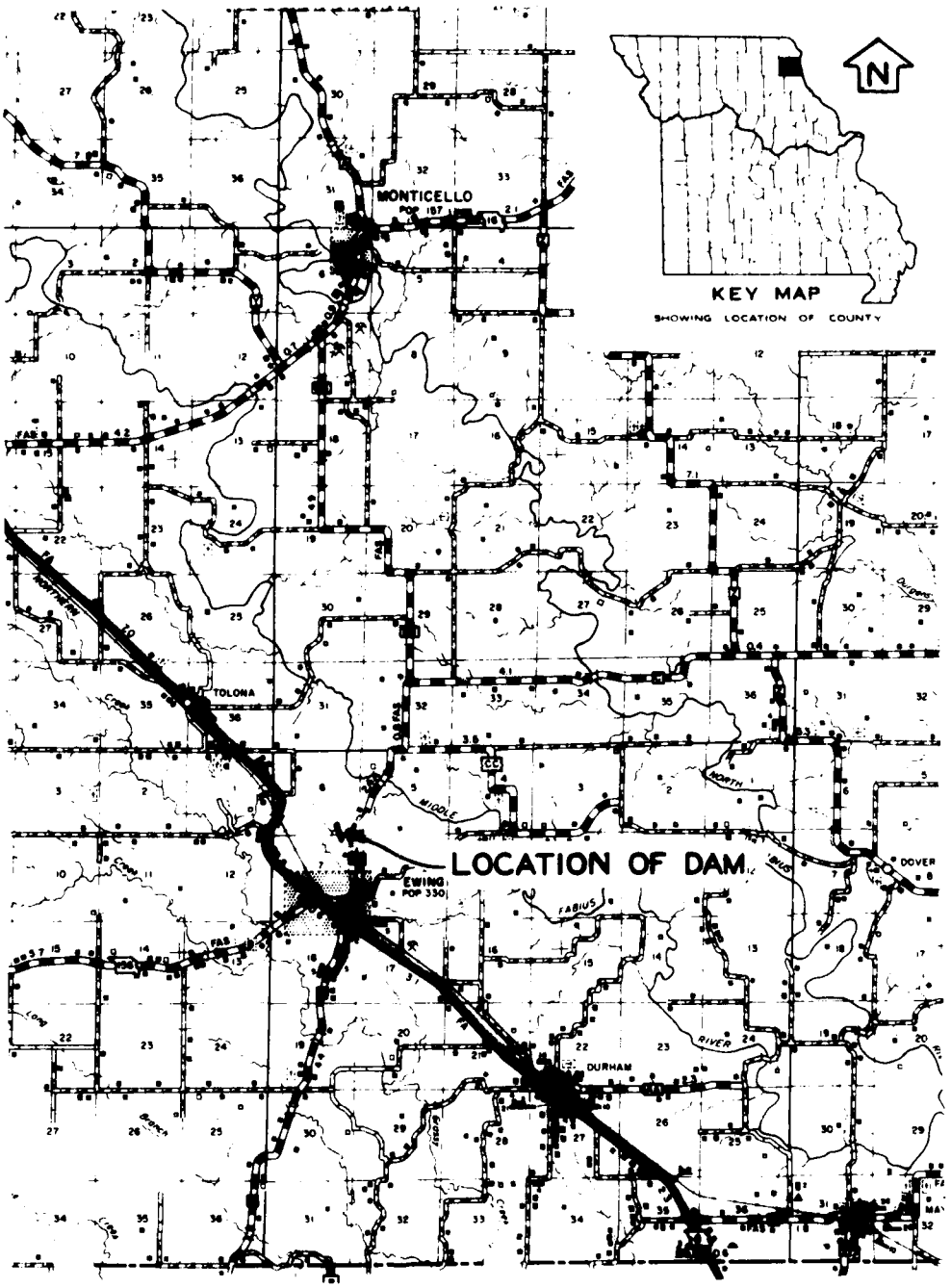
In addition, the owner should initiate the following programs.

1. Annual inspection of the dam by a professional engineer experienced in the design and construction of earthen dams.

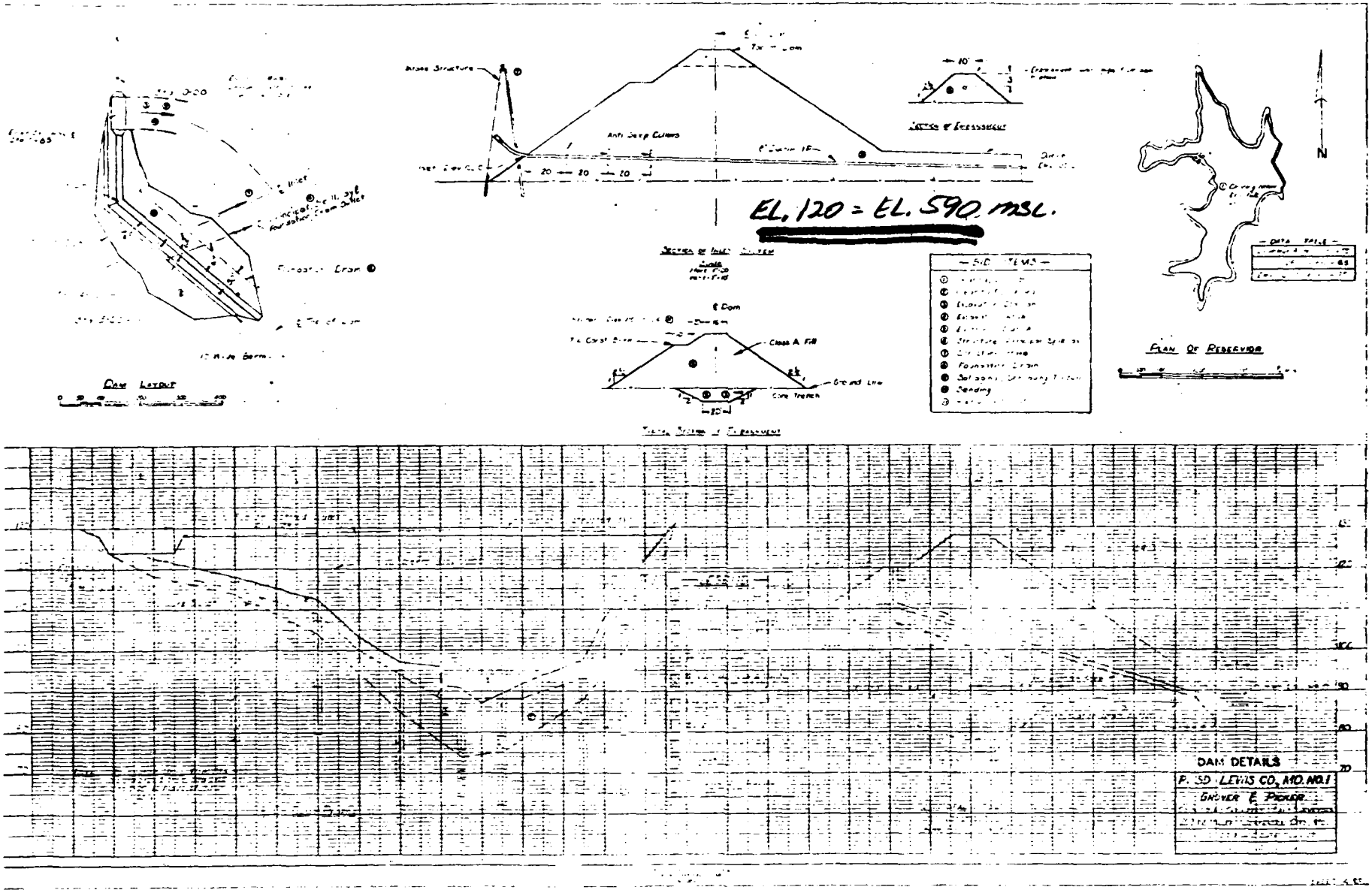
2. Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.

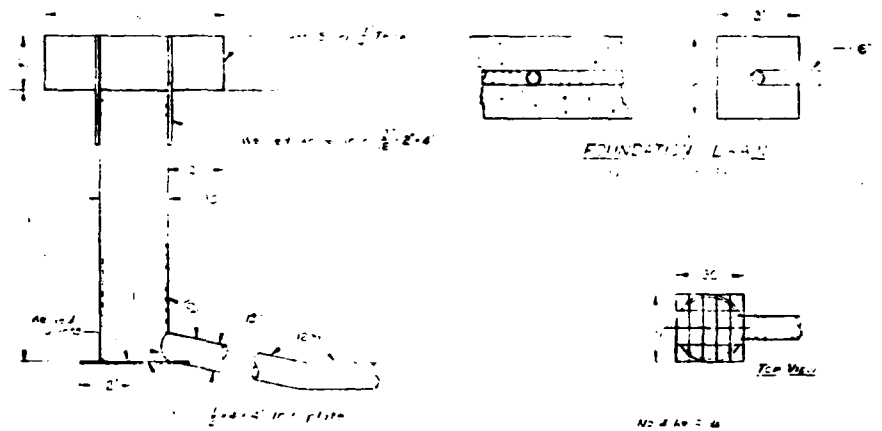
3. Perform seepage and stability analyses by a qualified professional engineer experienced in design and construction of dams.

PLATES



LOCATION MAP
EWING DAM
LEWIS COUNTY, MISSOURI

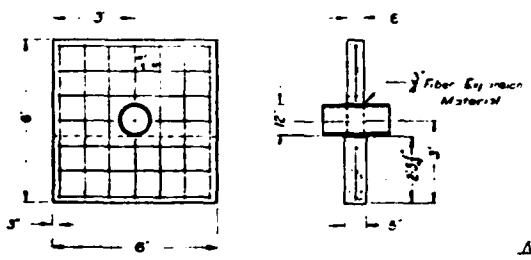

Dam Layout
Anti Seep Collars
EL. 120 = EL. 590 MSL.
Plan Of Reservoir
DAM DETAILS
P. SD. LEWIS CO., MO. NO. 1
GROVER E. PICKER



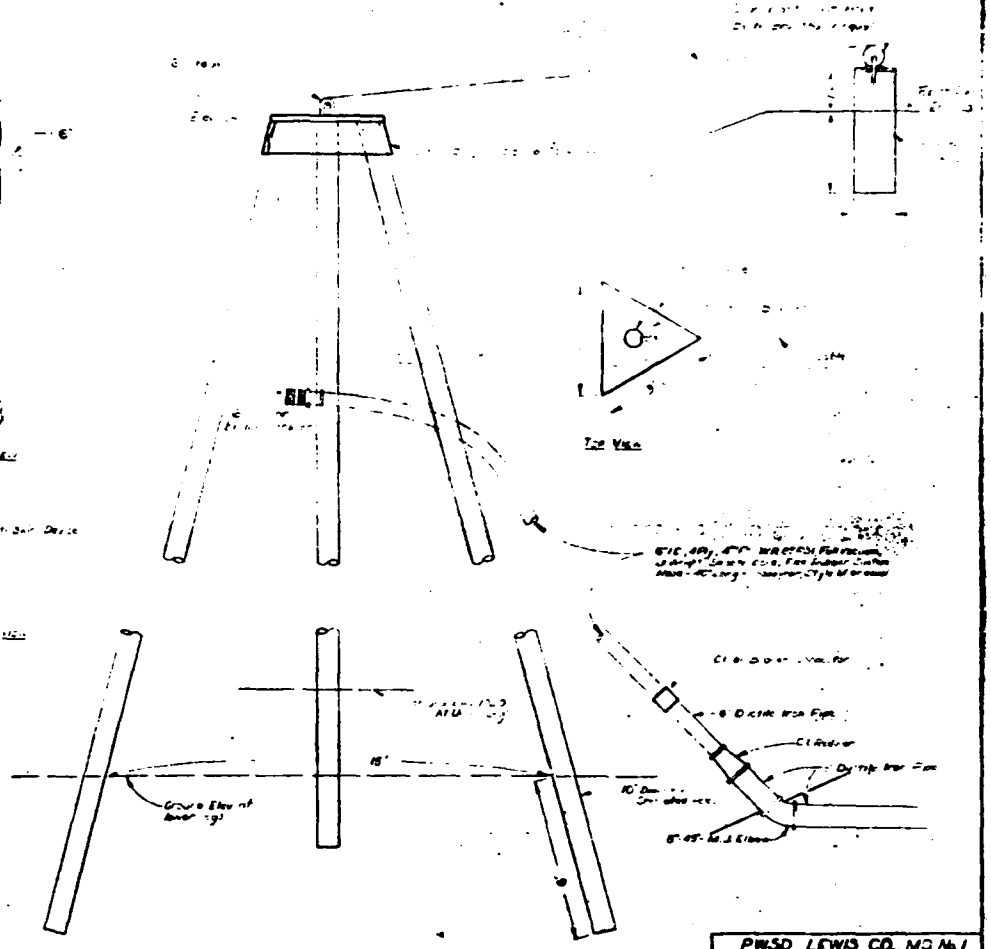
INLET & ELEV.

FOUNDATION LEVEL

TRASH RACK



ANTI-SEEP COLLAR



INTAKE STRUCTURE

(NOT TO SCALE)

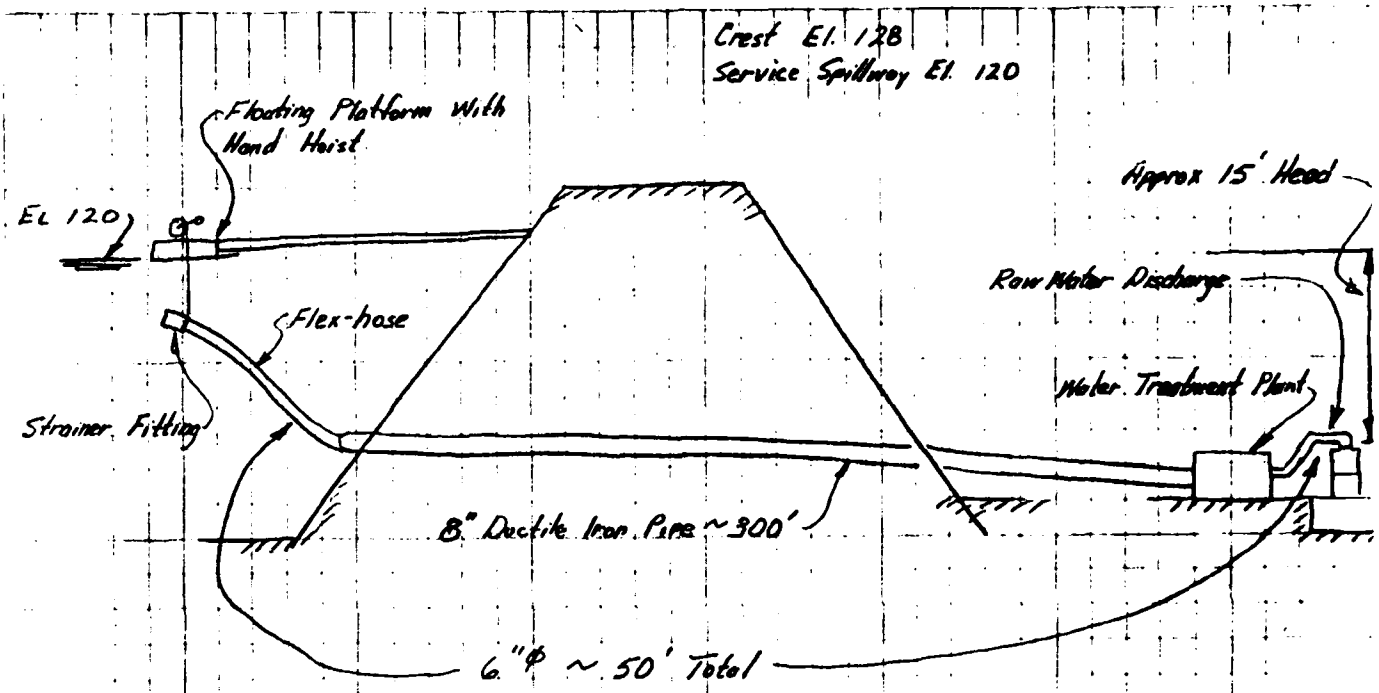
PWSD LEWIS CO. NO No. 1
— DAM DETAILS —
GRONER & PICKEL
CONSULTING ENGINEERS & LAND SURVEYORS
207 W. MULLEN JEFFERSON CITY, MO.

ECI-4 ENGINEERING CONSULTANTS, INC.

EWING DAM - MISSOURI SHEET NO. ____ OF ____

INVESTIGATE DRAWDOWN EFFECTIVENESS OF RAW WATER JOB NO. 1233

SUPPLY LINE BY JCF DATE 10/10/78



Determine overall flow coefficient

Assume Q = 1300 gpm

8" Pipe:

$h_L = 2.94 \times 3 = 8.82'$

6" Pipe:

$h_L = 10.2 \times .5 = 5.1'$

Entrance Loss:

Assume coefficient = 0.6

$h_L = .6 \times \frac{V^2}{2g} = .6(3.24) = 1.9'$

Exit Loss:

Equals one velocity head = 3.24' = 3.2'

4

Totals

8.8
5.1
1.9
3.2
19.0 = H_L TOTAL @ 1300 gpm

Determine Q for 15' head

$$Q = \sqrt{\frac{15}{19}} \times 1300 = 1155 \text{ gpm} = 2.6 \text{ CFS}$$

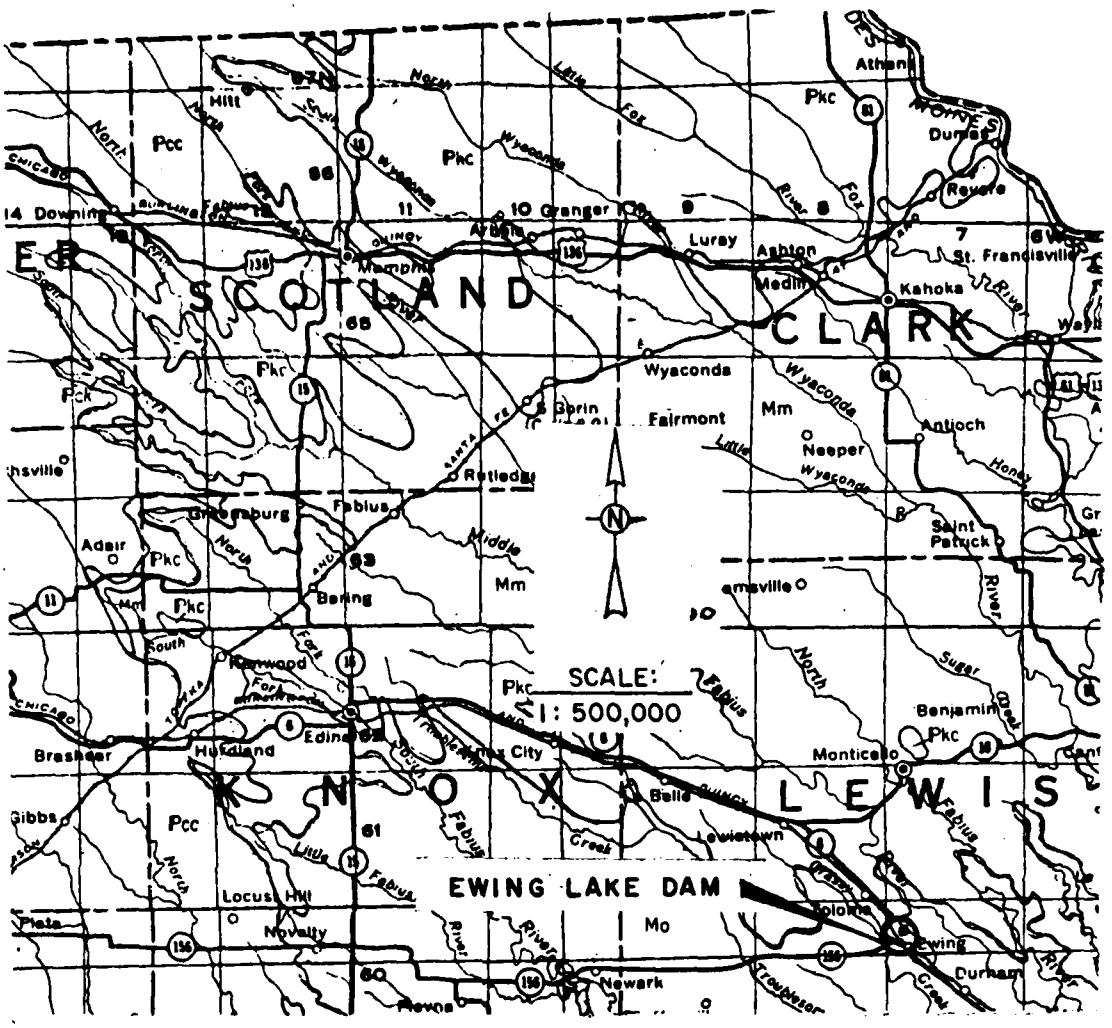
Surface area of reservoir = 45 acres at El. 120

Time to drawdowne one foot

$$= \frac{45 \text{ acres} \times 43{,}560 \text{ ft}^2/\text{acre}}{2.6 \times 60 \times 60 \times 24} = 8.7 \text{ days}$$

Several weeks would be required to draw the reservoir down any appreciable amount. This is too slow for most situations where emergency drawdown might be necessary.

An alternative would be siphoning or pumping through the service spillway pipe or over the emergency spillway crest.



Explanation

Pennsylvanian System

P_{kc} - Kansas City group: cyclic deposits with numerous limestones.
P_{pwm} - Pleasanton group: sandstone channel member.
P_{m} - Marmaton group: cyclic deposits with limestones.
P_{cc} - Cherokee group: cyclic deposits, predominately shale, sandstone and coal beds.

Mississippian System

M_{m} - sandy, oolitic, fossiliferous, lithographic, or cherty limestones.
M_{o} - cherty, crinoidal limestone, with some shale.
M_{k} - intercalated limestones and shales.

Reference: Geologic Map of Missouri, 1961, Division of Geological Survey and Water Resources, State of Missouri.

General Geologic Map

APPENDIX A

PHOTOGRAPHS TAKEN DURING INSPECTION

EWING DAM

Photo 1 - View along crest of dam taken at right abutment.

Photo 2 - View of upstream slope of dam taken from right side of dam.

Photo 3 - View along upstream slope of dam taken at right abutment.

Photo 4 - View along downstream slope of dam taken at left abutment of dam.

Photo 5 - View along downstream slope of dam taken at left abutment.

Photo 6 - Surface erosion path on downstream slope at right abutment contact.

Photo 7 - Picture of intake structure and hoist for water supply piping.

Photo 8 - Picture of water supply pump house.

Photo 9 - Picture of concrete block shaft which receives water from settling basin overflow and backwash cycle.

Photo 10 - Picture of discharge pipe from shaft shown in previous photo and pond formed by discharge.

Photo 11 - Picture of intake structure with grating for service spillway.

Photo 12 - Picture of discharge end of pipe used for service spillway and same pond shown in Photo 10.

Photo 13 - View across emergency spillway taken at left abutment.

Photo 14 - Picture of typical condition of emergency spillway channel.

Photo 1 - View along crest of dam taken at right abutment.

Photo 2 - View of upstream slope of dam taken from right side of dam.

Photo 3 - View along upstream slope of dam taken at right abutment.

Photo 4 - View along downstream slope of dam taken at left abutment of dam.

Photo 5 - View along downstream slope of dam taken at left abutment.

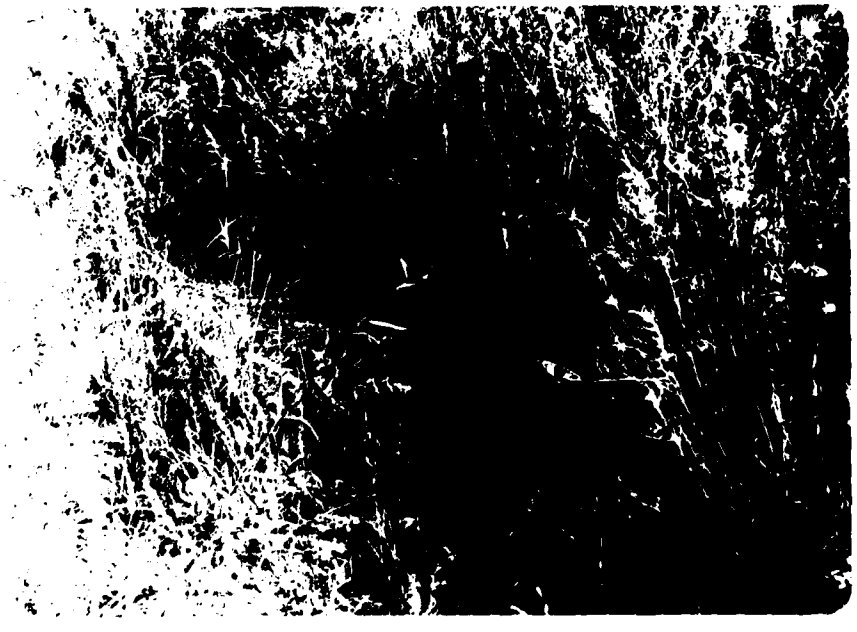


Photo 6 - Surface erosion path on downstream slope at right abutment contact.

Photo 7 - Picture of intake structure and hoist for water supply piping.

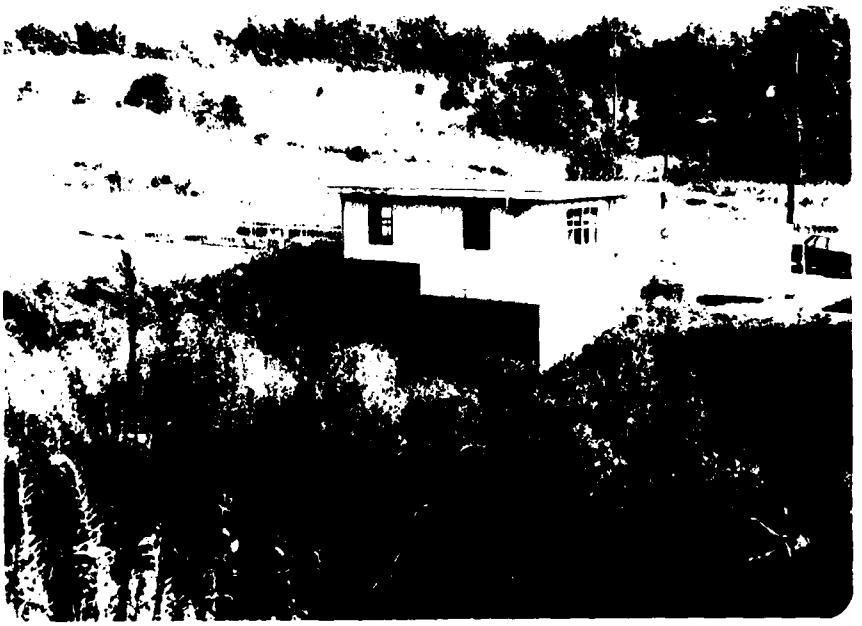


Photo 8 - Picture of water supply pump house.

Photo 9 - Picture of concrete block shaft which receives water from settling basin overflow and backwash cycle.

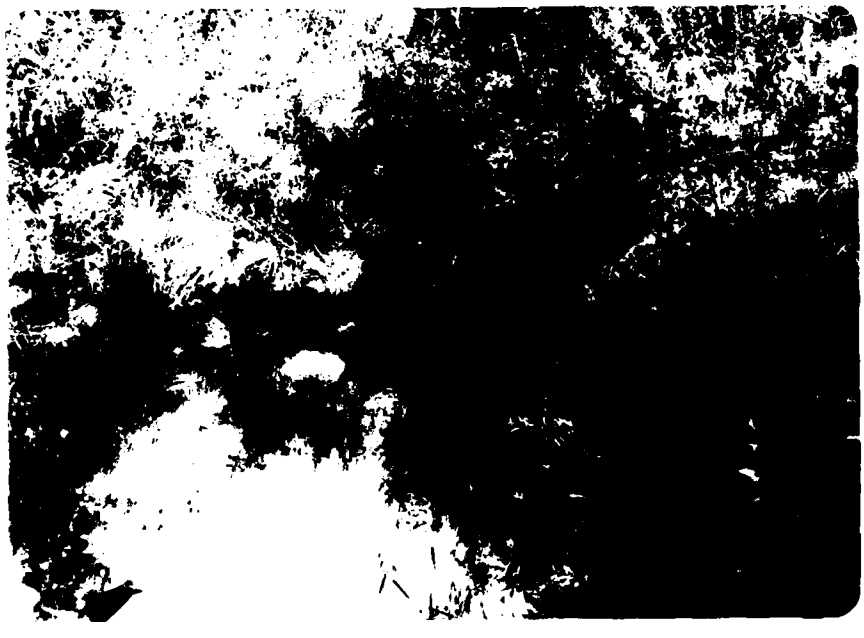


Photo 10 - Picture of discharge pipe from shaft shown in previous photo and pond formed by discharge.

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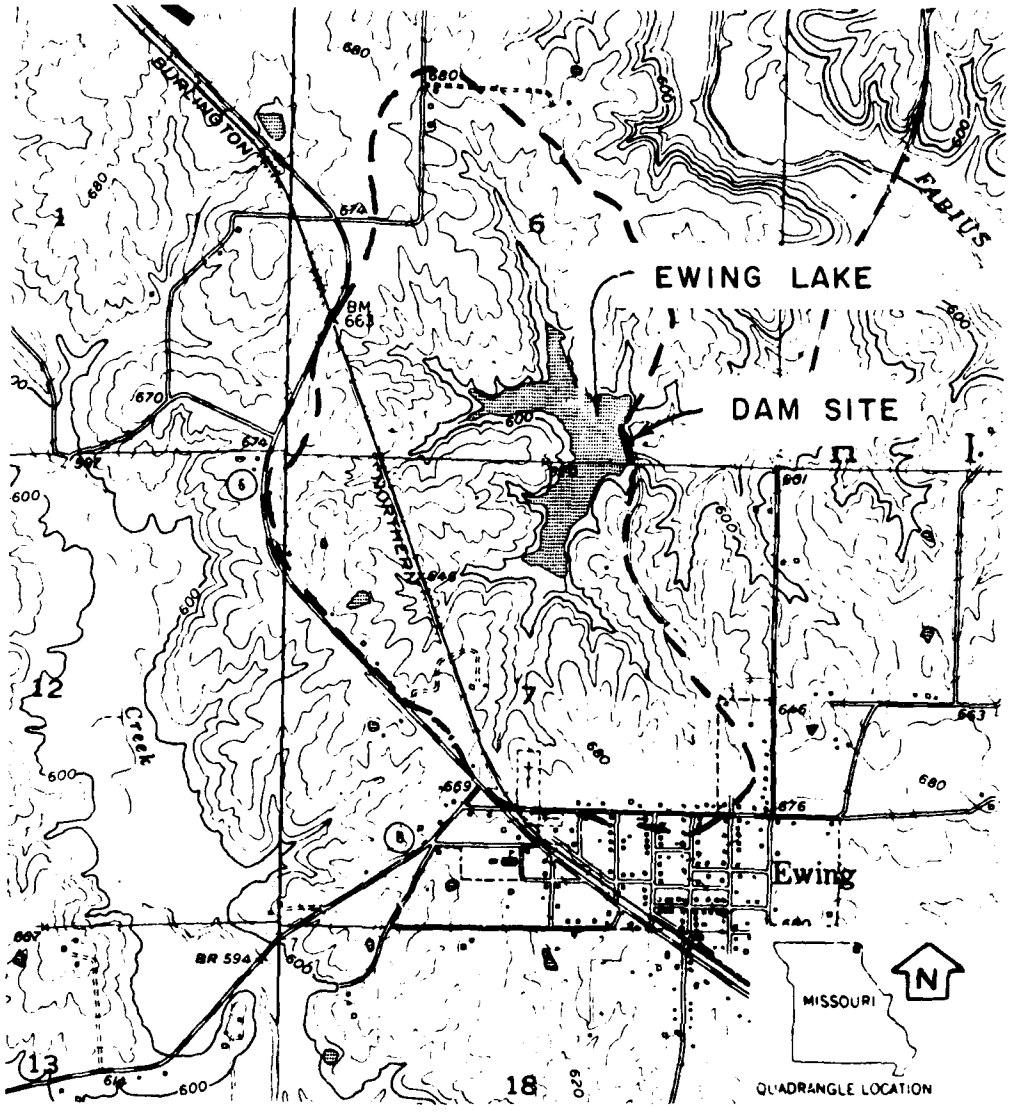
Photo 13 - View across emergency spillway taken at left abutment.

Photo 14 - Picture of typical condition of emergency spillway channel.

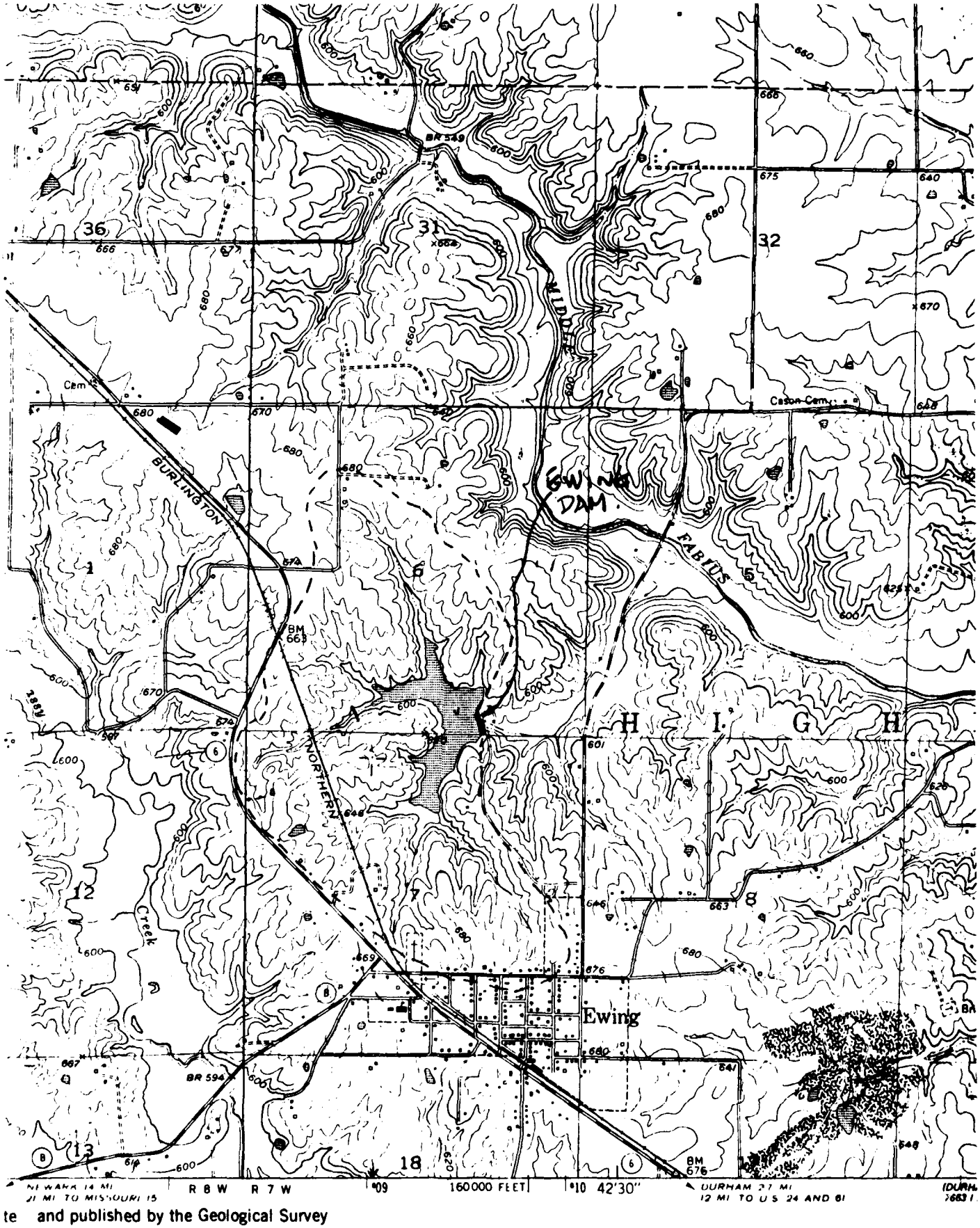
APPENDIX B

HYDROLOGIC COMPUTATIONS



CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
DRAINAGE BOUNDARY — — — —

EWING DAM
DRAINAGE AREA



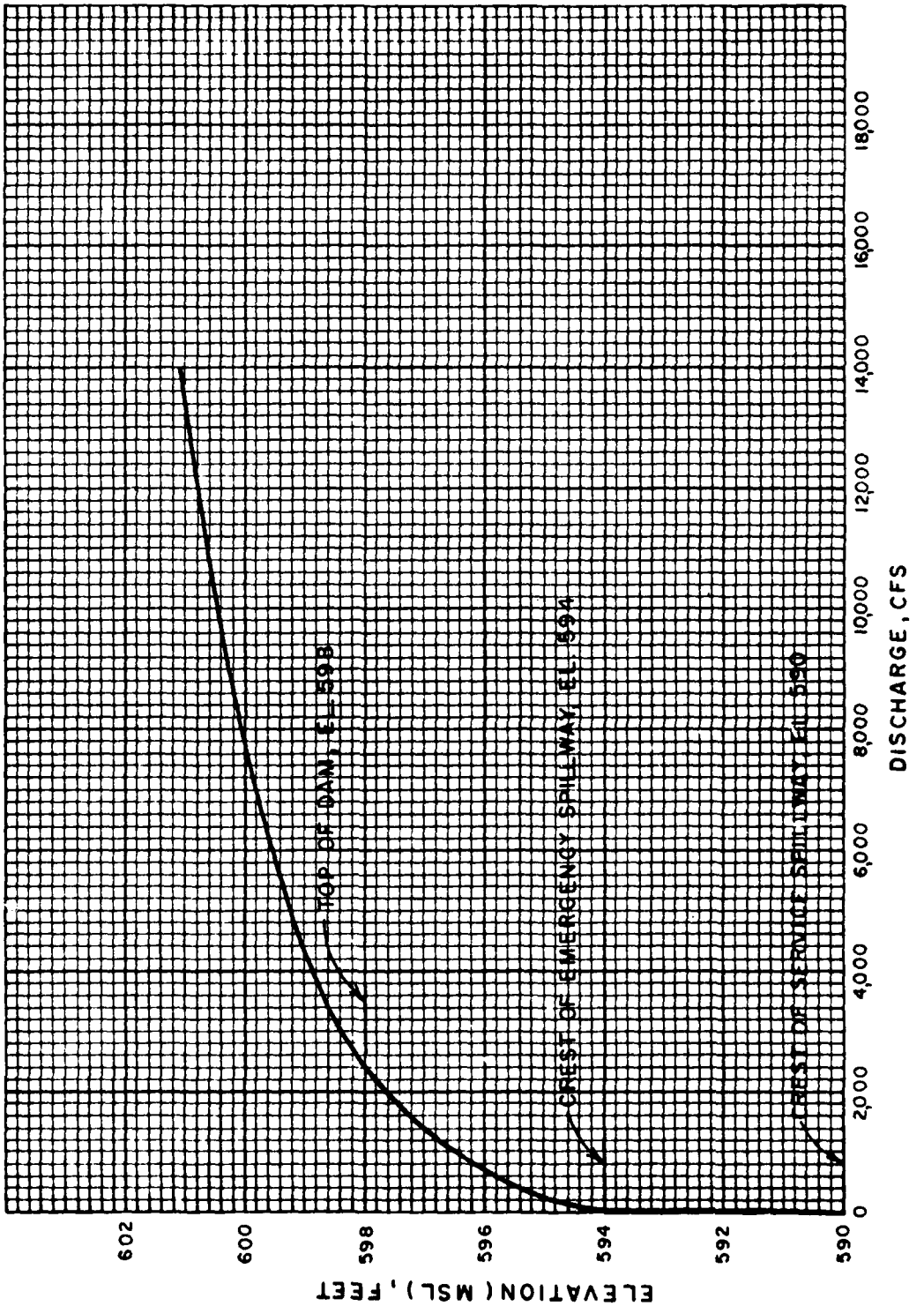
te and published by the Geological Survey

) and USC&GS

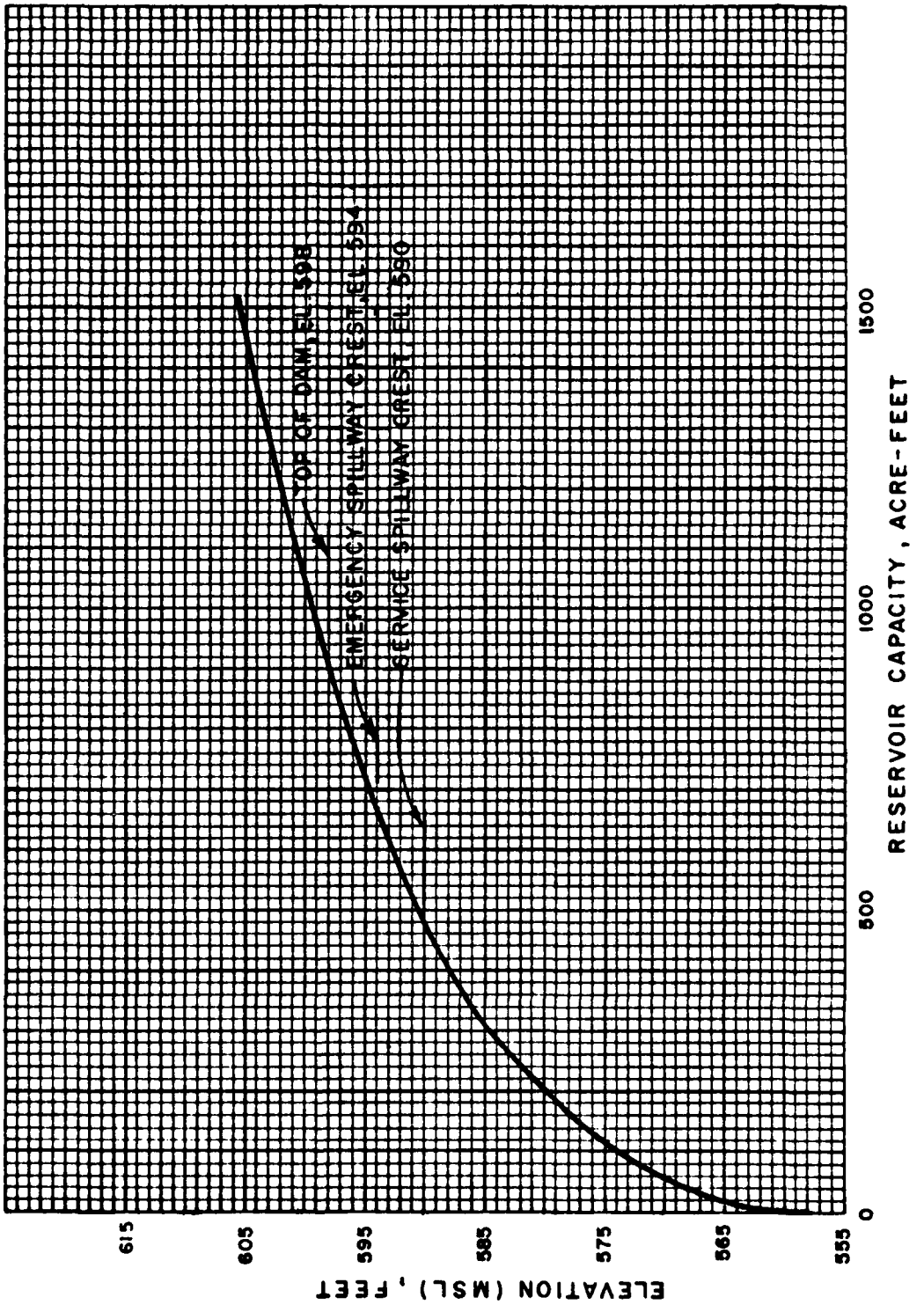
n aerial photographs by multiplex methods
hs taken 1947. Field checked 1950

MN
GN

SCALE 1:
0
1000 0



EWING DAM
COMBINED SPILLWAYS & OVERTOP RATING CURVE



EWING DAM
RESERVOIR CAPACITY CURVE

ECI-4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION – MISSOURI
EWING DAM
RESERVOIR AREA CAPACITY

SHEET NO. 1 OF 2
JOB NO. 1223-001-1
BY KLB DATE 10-18-78

EWING LAKE DAM

RESERVOIR AREA CAPACITY

Data used are based on USGS Monticello Quadrangle Sheet (7.5 minute series) in combination with data given in the National Dam Safety Inventory Table.

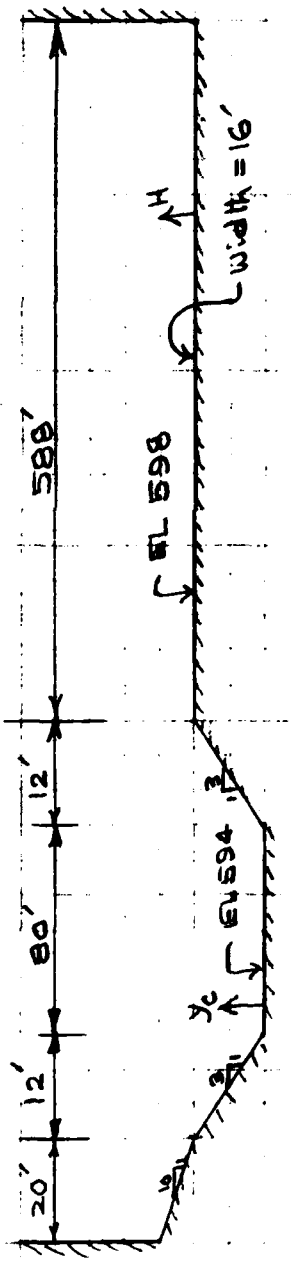
ELEV M.S.L. (FT)	RESERVOIR SURFACE AREA (ACRES)	INCREMENTAL VOLUME (AC-FT)	TOTAL VOLUME (AC-FT)	REMARKS
557	—	—	—	STREAMBED AT CENTERLINE OF DAM (ASSUMED LOCAL ELEV 0' = ELEV 557 MSL)
592	45	560	560	
594	48	93	653	EMERGENCY SPILLWAY CREST
598	65	228	881	TOP OF DAM
600	74	139	1020	
620	128	1878	3081	

ECI-4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION / MISSOURI — SHEET NO. 1 OF 1

EWING DAM — JOB NO. 1223-001

EMERGENCY SPILLWAY & OVERTOP DISCHARGE CAPACITY — BY MAS — DATE 10-18-78



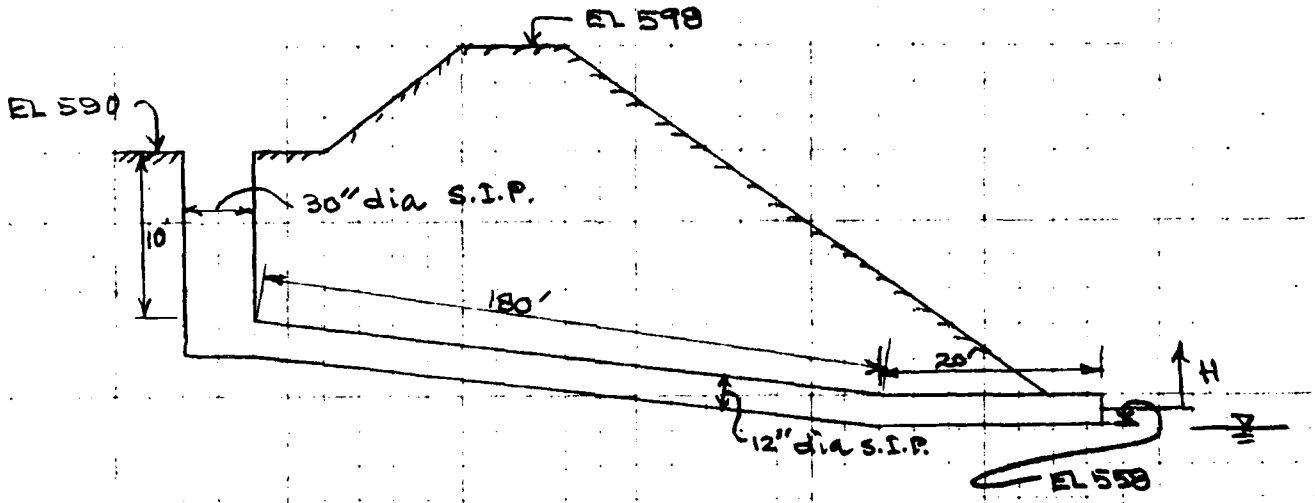
Yc	Tc	Ac	$Y_c = \sqrt{\frac{A_c}{T_c}}$	$\frac{V_c^2}{2g}$	Upstream W.S. El. = 594 + $Y_c + \frac{V_c^2}{2g}$	$Q_c = A_c V_c$	H	L	C	$Q = CLH^{3/2}$	$Q_T = Q_c + Q$
1	86	83	5.57	0.48	595.48	462					462
2	92	172	7.75	0.93	596.93	1333					1333
3	98	267	9.36	1.36	598.36	2490	0.84	588	2.70	343	2842
4	104	368	10.67	1.77	599.77	3927	1.77	588	2.63	3642	7569
5	114	477	11.60	2.09	601.09	5533	3.09	588	2.63	8400	13933
6	124	596	12.43	2.40	602.40	7408	4.40	588	2.63	14273	21681

FCI-4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION / MISSOURI — SHEET NO. 1 OF 2
EWING DAM — JOB NO. 1225-001
SERVICE SPILLWAY CAPACITY — BY MAS DATE 10-18-78

EWING LAKE DAM

SERVICE SPILLWAY CAPACITY



Upstream W.S. Elev @ 591

a) Weir flow:

Assume $C = 3.33$

$$Q = CLH^{3/2} = 3.33 \times \pi \times 2.5 \times 1^{3/2}$$

$$= 26 \text{ cfs}.$$

b) Pipe flow: Neglect entrance losses in 30" dia pipe

$$H = \left(1 + K_c + K_b + \frac{fL}{D}\right)\frac{V^2}{2g}$$

Assume $K_c = 0.5$, $K_b \approx .16$ & $\epsilon = 0.00085'$

$$\frac{\epsilon}{D} = 0.00085 \Rightarrow f = 0.019$$ assuming complete turb. flow.

ECI-4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION / MISSOURI — SHEET NO. 2 OF 2
EWING DAM — JOB NO. 1223-001
SERVICE SPILLWAY CAPACITY — BY MAS DATE 10-18-78

$$H = \left(1 + 0.5 + 0.16 + \frac{0.019 \times 200}{1}\right)\frac{V^2}{2g}$$

$$= 5.46\frac{V^2}{2g}$$

$$\therefore V = \frac{1}{\sqrt{5.46}}\sqrt{2gH} = 0.43\sqrt{2gH}$$

$$\boxed{Q = 0.43A\sqrt{2gH}}$$

$$Q = 0.43 \times .785\sqrt{64.4(591 - 558.5)}$$

$$= 154 \text{ cfs}$$

$\therefore$ SAY $\underline{\underline{Q = 16 \text{ cfs}}}$

Upstream W.S. Elev. ft.	Head H ft.	$Q = 0.43 \times .785 \times \sqrt{2gH}$
591	32.7	16 cfs
592	33.7	16 cfs
593	34.7	16 cfs
595.48	36.98	17 cfs
596.93	38.43	17 cfs
598.36	39.86	17 cfs
599.77	41.27	18 cfs
601.09	42.59	18 cfs
602.40	43.90	18 cfs

ECI-4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION / MISSOURI SHEET NO. 1 OF 2

EWING DAM JOB NO. 1223-001

COMBINED SPILLWAYS & OVERTOP DISCHARGE CAPACITY BY MAG DATE 10-19-78

EWING LAKE DAM

COMBINED SPILLWAYS & OVERTOP DISCHARGE CAPACITY

Upstream W.S. Elev. (ft.)	Emergency Spillway & overtop discharge (cfs)	Service Spillway discharge (cfs)	Total discharge (cfs)	Remarks
590	0	0	0	Crest of Serv. Spillway
591	0	16	16	
592	0	16	16	Crest of Em. Spillway
595.48	462	17	479	
596.93	1333	17	1350	
598.36	2842	17	2859	
599.77	7569	18	7587	
601.09	13933	18	13951	
602.40	21681	18	21699	

ECI-4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI — SHEET NO. 1 OF
EWING DAM — JOB NO. 1223-001-1
UNIT HYDROGRAPH PARAMETERS — BY KLB DATE 10-10-78

1. DRAINAGE AREA = 655 AC = 1.02 SQ. MI.

2. LENGTH OF STREAM = L = (11.7" x 2000')/5280' = 0.64 mi

3. DIFFERENCE IN ELEVATION: ΔH

$\Delta H = 690 - 570 = 100$ FT.

4. TIME OF CONCENTRATION

$$T_c = \left(\frac{11.9 \times L^3}{\Delta H}\right)^{0.385} = \left(\frac{11.9 \times 0.64^3}{100}\right)^{0.385}$$

$T_c = 0.26$ HR

5. LAG TIME = $L_t = 0.6 \times T_c$

$L_t = 0.6 \times 0.26 = 0.16$ HR

6. UNIT DURATION

$D \leq \frac{L_t}{3} = \frac{0.16}{3} = 0.05$ HR

USE $D = 5$ MIN $= 0.083$ HR

(MINIMUM DURATION CRITERIA

7. TIME TO PEAK

$T_p = \frac{D}{2} + 0.6 \times T_c$

$T_p = \frac{0.083}{2} + 0.6 \times 0.26$

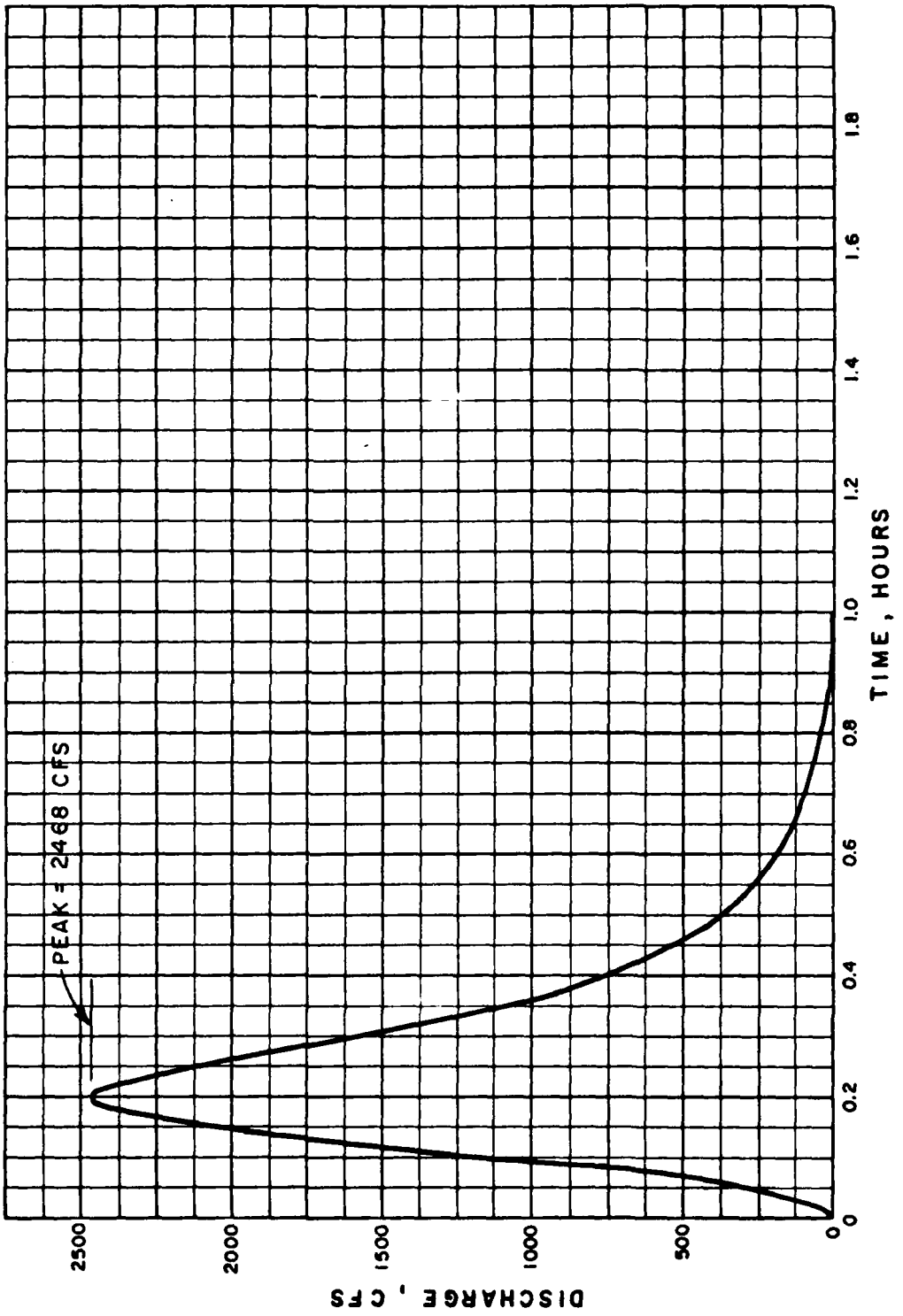
$T_p = 0.20$

8 $q_p = \frac{484 A}{T_p} = \frac{484 \times 1.02}{0.20} = 2468.40$ CFS

7) CURVILINEAR UNIT HYDROGRAPH

TIME T/TP	DISCHARGE RATIO Q/QP	UNIT HYDROGRAPH TIME, T (HOURS)	UNIT HYDROGRAPH DISCHARGE (CFS)
0.0	0.000	0.00	0.00
0.1	0.015	0.02	37.03
0.2	0.075	0.04	185.13
0.3	0.16	0.06	394.94
0.4	0.28	0.08	691.15
0.5	0.45	0.10	1110.78
0.6	0.60	0.12	1481.04
0.7	0.77	0.14	1900.67
0.8	0.89	0.16	2196.88
0.9	0.97	0.18	2394.35
1.0	1.00	0.20	2468.40
1.1	0.98	0.22	2419.03
1.2	0.92	0.24	2270.93
1.3	0.84	0.26	2073.46
1.4	0.75	0.28	1851.30
1.5	0.66	0.30	1629.14
1.6	0.56	0.32	1382.30
1.8	0.42	0.36	1036.73
2.0	0.32	0.40	789.89
2.2	0.24	0.44	592.42
2.4	0.18	0.48	444.31
2.6	0.13	0.52	320.89
2.8	0.098	0.56	241.90
3.0	0.075	0.60	185.13
3.5	0.036	0.70	88.86
4.0	0.018	0.80	44.43
4.5	0.009	0.90	22.22
5.0	0.004	1.00	9.87

668.



EWING DAM
5 MINUTE UNIT HYDROGRAPH

EWING LAKE DAM

DETERMINATION OF PMS

1. Determine drainage area of the basin

   D.A. = 1.02 Sq.mi.

2. Determine PMP Index rainfall :

   Location of centroid of basin:

   Long. 91.72°; Lat.: 40.02°

   → PMP for 200 Sq.mi. & 24 hrs duration

   = 24" (from Fig 1, HMR NO 33)

3. Determine basin rainfall interms of percentage of PMP Index rainfall for various durations;

   Location: Long. 91.72°; Lat. 40.02°

   ⇒ Zone 7

Duration (Hrs.)	Percent of Index rainfall (%)	Total rainfall (inches)	Rainfall increments (inches)	Duration of increment (Hrs.)
6	100	24	24	6
12	120	28.8	4.8	6
24	130	31.2	2.4	12

EWING LAKE DAM

100-YEAR FLOOD BY REGRESSION EQUATION

Regression equation for 100-year flood for Missouri:

$$Q_{100} = 85.1 A^{0.934} A^{-0.02} S^{0.576}$$

where, A = drainage area in Sq. mi.

S = main channel slope ft./mi.
(Avg. slope between 0.1L & 0.85L)

For Ewing Lake Dam:

A = 655 acres = 1.02 Sq. mi

S = 78 ft/0.48 mi = 162.5 ft./mi

$$Q_{100} = 85.1 (1.02)^{0.934} (1.02)^{-0.02} (162.5)^{0.576}$$

$$= \underline{1627 \text{ cfs}}$$

HEC1DB INPUT DATA

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  21 AUG 78
**********
     1          A
     2          A                    DAM SAFETY INSPECTION - MISSOURI
     3          A                         EWING LAKE DAM
     4          A              PMF AND 50 PERCENT PMF DETERMINATION AND ROUTING
     5          B    300       0       5       0       0       0       0       0       0       0
     6          B1     5
     7          J     1       2       1
     8          J1   1.0     0.5
     9          K     0       6                                       1
    10          K1        INPUT INDEX PRECIPITATION AND RATIOS, INPUT SCS UNIT HYDROGRAPH
    11          M     1      -1    1.02            1.02     1.0
    12          P           20.00     100     120     130
    13          T                                               0.85    0.07
    14          U    16
    15          U1   0.0      80.    1500.    2468.    1810.    1000.     520.     270.     155.      80.
    16          U1   50.      25.      10.       5.       2.       0.
    17          Y             0.       1
    18          K     1       6                       2               1
    19          K1        ROUTE HYDROGRAPH THROUGH EWING LAKE DAM
    20          Y                                     1       1
    21          Y1    1                                                 -590.      -1
    22          Y4590.00  591.00  592.00  594.00  595.48  596.93  598.36  599.77  601.09  602.40
    23          Y5    0.      16.      18.      16.     479.    1350.    2859.    7587.   13951.   21699.
    24          B     0.     560.     653.     881.    1020.    3081.
    25          BE  557.     592.     594.     598.     600.     620.
    26          B$590.00
    27          BD598.00
    28          K     99
```

REVIEW OF SEQUENCE OF [illegible] METHOD CALCULATIONS

RUNOFF HYDROGRAPH AT
ROUTE HYDROGRAPH TO
END OF NETWORK

INFLOW PMF AND ONE-HALF PMF HYDROGRAPHS

```
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  21 AUG 78

RUN  DATE= 78/12/18.
     TIME= 13.56.59.
```

DAM SAFETY INSPECTION - MISSOURI
EWING LAKE DAM
PMF AND 50 PERCENT PMF DETERMINATION AND ROUTING

JOB SPECIFICATION

NO	NMR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	0	5	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 2 LRTIO= 1

RTIOS= 1.00 .50

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INPUT INDEX PRECIPITATION AND RATIOS, INPUT SCS UNIT H

ISTAB	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	-1	1.02	0.00	1.02	1.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.00	100.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOR	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	.85	.07	0.00	0.00

GIVEN UNIT GRAPH, NUMBER 18

0.	60.	1500.	2460.	1810.	1000.	520.	270.	135.	80.
50.	25.	10.	5.	2.	0.				

UNIT GRAPH TOTALS 7975. CFS OR 1.01 INCHES OVER THE AREA

RECESSION DATA

STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

END-OF-PERIOD FLOW

WITDA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	HR.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.15	151	.20	.19	.01	1440.

1.01	5.10	62	.01	0.00	.01	0.	1.01	17.40	212	.22	.21	.01	1180.
1.01	5.15	63	.01	0.00	.01	0.	1.01	17.45	213	.22	.21	.01	1176.
1.01	5.20	64	.01	.00	.01	0.	1.01	17.50	214	.22	.21	.01	1172.
1.01	5.25	65	.01	.01	.01	0.	1.01	17.55	215	.22	.21	.01	1168.
1.01	5.30	66	.01	.01	.01	3.	1.01	18.00	216	.22	.21	.01	1164.
1.01	5.35	67	.01	.01	.01	16.	1.01	18.05	217	.02	.01	.01	1160.
1.01	5.40	68	.01	.01	.01	34.	1.01	18.10	218	.02	.01	.01	1092.
1.01	5.45	69	.01	.01	.01	46.	1.01	18.15	219	.02	.01	.01	1092.
1.01	5.50	70	.01	.01	.01	52.	1.01	18.20	220	.02	.01	.01	1088.
1.01	5.55	71	.01	.01	.01	56.	1.01	18.25	221	.02	.01	.01	1336.
1.01	6.00	72	.01	.01	.01	58.	1.01	18.30	222	.02	.01	.01	1336.
1.01	6.05	73	.07	.06	.01	59.	1.01	18.35	223	.02	.01	.01	1332.
1.01	6.10	74	.07	.06	.01	63.	1.01	18.40	224	.02	.01	.01	1328.
1.01	6.15	75	.07	.06	.01	188.	1.01	18.45	225	.02	.01	.01	1479.
1.01	6.20	76	.07	.06	.01	276.	1.01	18.50	226	.02	.01	.01	1319.
1.01	6.25	77	.07	.06	.01	372.	1.01	18.55	227	.02	.01	.01	1211.
1.01	6.30	78	.07	.06	.01	426.	1.01	19.00	228	.02	.01	.01	116.
1.01	6.35	79	.07	.06	.01	453.	1.01	19.05	229	.02	.01	.01	116.
1.01	6.40	80	.07	.06	.01	468.	1.01	19.10	230	.02	.01	.01	113.
1.01	6.45	81	.07	.06	.01	476.	1.01	19.15	231	.02	.01	.01	113.
1.01	6.50	82	.07	.06	.01	480.	1.01	19.20	232	.02	.01	.01	113.
1.01	6.55	83	.07	.06	.01	483.	1.01	19.25	233	.02	.01	.01	113.
1.01	7.00	84	.07	.06	.01	484.	1.01	19.30	234	.02	.01	.01	113.
1.01	7.05	85	.07	.06	.01	485.	1.01	19.35	235	.02	.01	.01	113.
1.01	7.10	86	.07	.06	.01	485.	1.01	19.40	236	.02	.01	.01	113.
1.01	7.15	87	.07	.06	.01	485.	1.01	19.45	237	.02	.01	.01	113.
1.01	7.20	88	.07	.06	.01	485.	1.01	19.50	238	.02	.01	.01	113.
1.01	7.25	89	.07	.06	.01	485.	1.01	19.55	239	.02	.01	.01	113.
1.01	7.30	90	.07	.06	.01	485.	1.01	20.00	240	.02	.01	.01	113.
1.01	7.35	91	.07	.06	.01	485.	1.01	20.05	241	.02	.01	.01	113.
1.01	7.40	92	.07	.06	.01	485.	1.01	20.10	242	.02	.01	.01	113.
1.01	7.45	93	.07	.06	.01	485.	1.01	20.15	243	.02	.01	.01	113.
1.01	7.50	94	.07	.06	.01	485.	1.01	20.20	244	.02	.01	.01	113.
1.01	7.55	95	.07	.06	.01	485.	1.01	20.25	245	.02	.01	.01	113.
1.01	8.00	96	.07	.06	.01	485.	1.01	20.30	246	.02	.01	.01	113.
1.01	8.05	97	.07	.06	.01	485.	1.01	20.35	247	.02	.01	.01	113.
1.01	8.10	98	.07	.06	.01	485.	1.01	20.40	248	.02	.01	.01	113.
1.01	8.15	99	.07	.06	.01	485.	1.01	20.45	249	.02	.01	.01	113.
1.01	8.20	100	.07	.06	.01	485.	1.01	20.50	250	.02	.01	.01	113.
1.01	8.25	101	.07	.06	.01	485.	1.01	20.55	251	.02	.01	.01	113.
1.01	8.30	102	.07	.06	.01	485.	1.01	21.00	252	.02	.01	.01	113.
1.01	8.35	103	.07	.06	.01	485.	1.01	21.05	253	.02	.01	.01	113.
1.01	8.40	104	.07	.06	.01	485.	1.01	21.10	254	.02	.01	.01	113.
1.01	8.45	105	.07	.06	.01	485.	1.01	21.15	255	.02	.01	.01	113.
1.01	8.50	106	.07	.06	.01	485.	1.01	21.20	256	.02	.01	.01	113.
1.01	8.55	107	.07	.06	.01	485.	1.01	21.25	257	.02	.01	.01	113.
1.01	9.00	108	.07	.06	.01	485.	1.01	21.30	258	.02	.01	.01	113.
1.01	9.05	109	.07	.06	.01	485.	1.01	21.35	259	.02	.01	.01	113.
1.01	9.10	110	.07	.06	.01	485.	1.01	21.40	260	.02	.01	.01	113.
1.01	9.15	111	.07	.06	.01	485.	1.01	21.45	261	.02	.01	.01	113.
1.01	9.20	112	.07	.06	.01	485.	1.01	21.50	262	.02	.01	.01	113.
1.01	9.25	113	.07	.06	.01	485.	1.01	21.55	263	.02	.01	.01	113.
1.01	9.30	114	.07	.06	.01	485.	1.01	22.00	264	.02	.01	.01	113.
1.01	9.35	115	.07	.06	.01	485.	1.01	22.05	265	.02	.01	.01	113.
1.01	9.40	116	.07	.06	.01	485.	1.01	22.10	266	.02	.01	.01	113.
1.01	9.45	117	.07	.06	.01	485.	1.01	22.15	267	.02	.01	.01	113.
1.01	9.50	118	.07	.06	.01	485.	1.01	22.20	268	.02	.01	.01	113.
1.01	9.55	119	.07	.06	.01	485.	1.01	22.25	269	.02	.01	.01	113.
1.01	10.00	120	.07	.06	.01	485.	1.01	22.30	270	.02	.01	.01	113.
1.01	10.05	121	.07	.06	.01	485.	1.01	22.35	271	.02	.01	.01	113.

1.01	10.10	122	.07	.06	.01	485.	1.01	22.40	272	.02	.01	.01	113.
1.01	10.15	123	.07	.06	.01	485.	1.01	22.45	273	.02	.01	.01	113.
1.01	10.20	124	.07	.06	.01	485.	1.01	22.50	274	.02	.01	.01	113.
1.01	10.25	125	.07	.06	.01	485.	1.01	22.55	275	.02	.01	.01	113.
1.01	10.30	126	.07	.06	.01	485.	1.01	23.00	276	.02	.01	.01	113.
1.01	10.35	127	.07	.06	.01	485.	1.01	23.05	277	.02	.01	.01	113.
1.01	10.40	128	.07	.06	.01	485.	1.01	23.10	278	.02	.01	.01	113.
1.01	10.45	129	.07	.06	.01	485.	1.01	23.15	279	.02	.01	.01	113.
1.01	10.50	130	.07	.06	.01	485.	1.01	23.20	280	.02	.01	.01	113.
1.01	10.55	131	.07	.06	.01	485.	1.01	23.25	281	.02	.01	.01	113.
1.01	11.00	132	.07	.06	.01	485.	1.01	23.30	282	.02	.01	.01	113.
1.01	11.05	133	.07	.06	.01	485.	1.01	23.35	283	.02	.01	.01	113.
1.01	11.10	134	.07	.06	.01	485.	1.01	23.40	284	.02	.01	.01	113.
1.01	11.15	135	.07	.06	.01	485.	1.01	23.45	285	.02	.01	.01	113.
1.01	11.20	136	.07	.06	.01	485.	1.01	23.50	286	.02	.01	.01	113.
1.01	11.25	137	.07	.06	.01	485.	1.01	23.55	287	.02	.01	.01	113.
1.01	11.30	138	.07	.06	.01	485.	1.02	0.00	288	.02	.01	.01	113.
1.01	11.35	139	.07	.06	.01	485.	1.02	.05	289	0.00	0.00	0.00	113.
1.01	11.40	140	.07	.06	.01	485.	1.02	.10	290	0.00	0.00	0.00	113.
1.01	11.45	141	.07	.06	.01	485.	1.02	.15	291	0.00	0.00	0.00	91.
1.01	11.50	142	.07	.06	.01	485.	1.02	.20	292	0.00	0.00	0.00	56.
1.01	11.55	143	.07	.06	.01	485.	1.02	.25	293	0.00	0.00	0.00	30.
1.01	12.00	144	.07	.06	.01	485.	1.02	.30	294	0.00	0.00	0.00	16.
1.01	12.05	145	.20	.19	.01	485.	1.02	.35	295	0.00	0.00	0.00	8.
1.01	12.10	146	.20	.19	.01	496.	1.02	.40	296	0.00	0.00	0.00	5.
1.01	12.15	147	.20	.19	.01	696.	1.02	.45	297	0.00	0.00	0.00	3.
1.01	12.20	148	.20	.19	.01	1029.	1.02	.50	298	0.00	0.00	0.00	1.
1.01	12.25	149	.20	.19	.01	1266.	1.02	.55	299	0.00	0.00	0.00	1.
1.01	12.30	150	.20	.19	.01	1400.	1.02	1.00	300	0.00	0.00	0.00	0.

SUM 31.20 29.08 2.16 231609.
(792.)(738.)(55.)(6558.16)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1173A.	2589.	804.	772.	231609.
CMS	332.	73.	23.	22.	6558.
INCHES		25.61	29.34	29.34	29.34
MM		900.70	745.16	745.16	745.16
AC-FT		1288.	1595.	1595.	1595.
THOUS CU M		1583.	1968.	1968.	1968.

HYDROGRAPH AT STA 6 FOR PLAN 1, RTIO 1

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	3.	16.	36.	66.	52.
56.	58.	59.	63.	144.	276.	372.	426.	453.	468.
476.	480.	483.	484.	485.	485.	485.	485.	485.	485.
485.	485.	485.	485.	485.	485.	485.	485.	485.	485.
485.	485.	485.	485.	485.	485.	485.	485.	485.	485.
485.	485.	485.	485.	485.	485.	485.	485.	485.	485.
485.	485.	485.	485.	485.	485.	485.	485.	485.	485.
485.	485.	485.	485.	485.	485.	485.	485.	485.	485.
485.	485.	485.	485.	485.	496.	696.	1029.	1266.	1400.
1489.	1505.	1520.	1536.	1543.	1546.	1548.	1551.	1612.	1710.

1783.	1823.	1844.	1854.	1861.	1864.	1866.	1867.	1867.	1878.
1962.	2110.	2219.	2279.	2310.	2326.	2336.	2340.	2383.	2389.
2346.	2336.	2175.	2158.	2418.	2903.	3685.	5751.	9761.	11738.
10190.	7869.	5960.	4586.	3678.	3030.	2651.	2432.	2310.	2280.
2216.	2199.	2191.	2188.	2187.	2182.	2092.	1944.	1838.	1775.
1744.	1728.	1718.	1713.	1710.	1709.	1708.	1692.	1392.	898.
536.	336.	232.	178.	147.	131.	121.	116.	114.	113.
113.	113.	113.	113.	113.	113.	113.	113.	113.	113.
113.	113.	113.	113.	113.	113.	113.	113.	113.	113.
113.	113.	113.	113.	113.	113.	113.	113.	113.	113.
113.	113.	113.	113.	113.	113.	113.	113.	113.	113.
113.	113.	113.	113.	113.	113.	113.	113.	113.	112.
113.	113.	113.	113.	113.	113.	113.	113.	113.	112.
91.	56.	30.	16.	8.	5.	2.	1.	1.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	11738.	2589.	804.	772.	231609.
CMS	332.	73.	23.	22.	6558.
INCHES		23.61	29.34	29.34	29.34
MM		599.70	745.16	745.16	745.16
AC-FT		1284.	1595.	1595.	1595.
THOUS CU M		1583.	1968.	1968.	1968.

HYDROGRAPH AT STA 6 FOR PLAN 1, RTIO 2

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	2.	8.	17.	23.	26.
28.	29.	29.	32.	72.	138.	186.	213.	227.	238.
238.	240.	241.	242.	242.	243.	243.	243.	243.	243.
243.	243.	243.	243.	243.	243.	243.	243.	243.	243.
243.	243.	243.	243.	243.	243.	243.	243.	243.	243.
243.	243.	243.	243.	243.	243.	243.	243.	243.	243.
243.	243.	243.	243.	243.	243.	243.	243.	243.	243.
243.	243.	243.	243.	243.	243.	243.	243.	243.	243.
243.	243.	243.	243.	243.	248.	348.	512.	633.	700.
734.	752.	763.	768.	771.	773.	774.	776.	806.	855.
891.	911.	922.	927.	930.	932.	933.	935.	934.	936.
981.	1055.	1109.	1139.	1155.	1163.	1168.	1170.	1172.	1172.
1173.	1160.	1087.	1079.	1205.	1452.	1842.	2876.	4081.	5009.
3695.	3434.	2980.	2298.	1839.	1515.	1326.	1216.	1155.	1125.
1108.	1099.	1096.	1094.	1094.	1091.	1046.	972.	917.	887.
872.	864.	859.	857.	855.	854.	854.	846.	696.	489.
268.	168.	116.	89.	74.	66.	61.	58.	57.	57.
58.	56.	56.	56.	56.	56.	56.	56.	56.	56.
56.	56.	56.	56.	56.	56.	56.	56.	56.	56.
56.	56.	56.	56.	56.	56.	56.	56.	56.	56.
56.	56.	56.	56.	56.	56.	56.	56.	56.	56.
56.	56.	56.	56.	56.	56.	56.	56.	56.	56.
56.	56.	56.	56.	56.	56.	56.	56.	56.	56.
38.	28.	15.	8.	4.	2.	1.	1.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5869.	1294.	402.	386.	115804.
CMS	166.	37.	11.	11.	3279.

PMF FLOOD ROUTING

INCHES		11.81	14.67	14.67	14.67
MM		299.85	372.58	372.58	372.58
AC-FT		642.	798.	798.	798.
THOUS CU M		792.	984.	984.	984.

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HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THROUGH EWING LAKE DAM

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	1	0	0	2	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	=590.	=1

STAGE	590.0	591.0	592.0	594.0	595.5	596.9	598.4	599.8	601.1	602.6
FLOW	0.	16.	16.	16.	479.	1350.	2859.	7587.	13951.	21699.
CAPACITY=	0.	560.	653.	881.	1020.	5081.				
ELEVATION=	587.	592.	594.	598.	600.	620.				

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
590.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
598.0	0.0	0.0	0.

STATION 6, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	1.	1.
1.	2.	2.	2.	3.	5.	7.	9.	12.	15.
16.	16.	16.	16.	16.	16.	16.	16.	16.	16.
16.	16.	16.	16.	16.	16.	16.	16.	16.	16.
16.	16.	16.	16.	16.	16.	16.	16.	16.	16.
16.	16.	16.	16.	34.	51.	67.	82.	97.	112.
129.	139.	150.	164.	176.	187.	198.	209.	219.	229.
238.	248.	257.	265.	273.	281.	289.	296.	303.	310.
316.	323.	329.	334.	340.	346.	355.	374.	402.	437.
478.	540.	606.	673.	738.	790.	843.	893.	941.	991.
1048.	1097.	1149.	1198.	1244.	1287.	1328.	1377.	1435.	1487.

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 1539.    1599.    1666.    1730.    1803.    1864.    1920.    1969.    2013.    2058.
 2087.    2117.    2133.    2137.    2150.    2214.    2344.    2603.    3593.    5632.
 7151.    7722.    7657.    6836.    6067.    5294.    4595.    4010.    3543.    3188.
 2912.    2808.    2746.    2693.    2643.    2597.    2552.    2499.    2430.    2355.
 2284.    2218.    2159.    2100.    2058.    2017.    1981.    1948.    1900.    1809.
 1678.    1530.    1380.    1285.    1207.    1132.    1062.     996.     934.     871.
  823.     773.     727.     684.     644.     607.     572.     540.     510.     482.
  467.     450.     441.     429.     417.     406.     395.     385.     375.     365.
  356.     347.     338.     330.     322.     314.     306.     299.     292.     286.
  279.     273.     267.     261.     256.     251.     246.     241.     236.     231.
  227.     223.     219.     215.     211.     207.     204.     200.     197.     194.
  191.     188.     185.     183.     180.     178.     175.     173.     171.     169.
  166.     163.     158.     153.     148.     143.     137.     132.     128.     123.

                                    STORAGE
  528.     528.     528.     528.     528.     528.     528.     528.     528.     528.
  528.     528.     528.     528.     528.     528.     528.     528.     528.     528.
  528.     528.     528.     528.     528.     528.     528.     528.     528.     528.
  528.     528.     528.     528.     528.     528.     528.     528.     528.     528.
  528.     528.     528.     528.     528.     528.     528.     528.     528.     528.
  528.     528.     528.     528.     528.     528.     528.     528.     528.     528.
  528.     528.     528.     528.     528.     528.     528.     528.     529.     529.
  529.     530.     530.     530.     531.     533.     535.     537.     540.     543.
  547.     550.     553.     556.     559.     563.     566.     569.     572.     576.
  579.     582.     585.     588.     592.     595.     598.     601.     605.     608.
  611.     614.     618.     621.     624.     627.     630.     634.     637.     640.
  643.     647.     650.     653.     656.     659.     662.     665.     668.     670.
  673.     675.     678.     680.     682.     684.     686.     688.     690.     692.
  694.     695.     697.     698.     700.     701.     703.     704.     705.     707.
  708.     709.     710.     711.     712.     713.     715.     718.     723.     730.
  736.     743.     750.     756.     762.     767.     772.     777.     781.     786.
  791.     796.     801.     806.     810.     814.     816.     821.     825.     827.
  830.     833.     837.     841.     844.     848.     851.     853.     856.     858.
  860.     861.     862.     863.     863.     867.     874.     889.     921.     963.
  995.    1006.    1001.     988.     973.     956.     942.     930.     920.     913.
  907.     903.     899.     895.     892.     889.     886.     882.     878.     874.
  870.     867.     864.     861.     858.     856.     854.     852.     850.     845.
  838.     830.     822.     814.     806.     799.     793.     786.     781.     775.
  770.     765.     761.     757.     753.     749.     746.     743.     740.     738.
  735.     733.     730.     728.     726.     724.     722.     720.     718.     717.
  715.     713.     712.     710.     709.     707.     706.     705.     703.     702.
  701.     700.     699.     698.     697.     696.     695.     694.     693.     692.
  691.     691.     690.     689.     689.     688.     687.     687.     686.     685.
  685.     684.     684.     683.     683.     682.     682.     682.     681.     681.
  680.     680.     679.     678.     677.     676.     675.     674.     673.     672.

                                     STAGE
 590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0
 590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0
 590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0
 590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0
 590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0
 590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0
 590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.0    590.1
 590.1    590.1    590.1    590.1    590.2    590.3    590.4    590.6    590.8    591.0
 591.2    591.4    591.6    591.8    592.0    592.1    592.1    592.2    592.3    592.3
 592.4    592.5    592.5    592.6    592.7    592.8    592.8    592.9    593.0    593.0
 593.1    593.2    593.2    593.3    593.4    593.4    593.5    593.6    593.7    593.7
 593.8    593.9    593.9    594.0    594.1    594.1    594.2    594.2    594.3    594.3
 594.3    594.4    594.4    594.5    594.5    594.5    594.6    594.6    594.6    594.7
```

594.7	594.7	594.8	594.8	594.8	594.8	594.9	594.9	594.9	594.9
595.0	595.0	595.0	595.0	595.0	595.1	595.1	595.1	595.2	595.3
595.5	595.6	595.7	595.8	595.9	596.0	596.1	596.2	596.2	596.3
596.4	596.5	596.6	596.7	596.8	596.8	596.9	597.0	597.0	597.1
597.1	597.2	597.2	597.3	597.4	597.4	597.5	597.5	597.6	597.6
597.6	597.7	597.7	597.7	597.7	597.7	597.9	598.1	598.0	598.2
598.6	598.8	598.7	598.5	598.3	598.1	598.9	598.7	598.6	598.5
598.4	598.3	598.3	598.2	598.2	598.1	598.1	598.0	598.0	597.9
597.8	597.8	597.7	597.6	597.6	597.6	597.5	597.5	597.5	597.4
597.2	597.1	597.0	596.8	596.7	596.6	596.5	596.3	596.2	596.1
596.1	596.0	595.9	595.9	595.8	595.7	595.6	595.6	595.5	595.5
595.4	595.4	595.4	595.3	595.3	595.2	595.2	595.2	595.1	595.1
595.1	595.1	595.0	594.9	595.0	595.0	594.9	594.9	594.9	594.9
594.8	594.8	594.8	594.8	594.8	594.7	594.7	594.7	594.7	594.7
594.7	594.7	594.6	594.6	594.6	594.6	594.6	594.6	594.6	594.6
594.6	594.6	594.5	594.5	594.5	594.5	594.5	594.5	594.5	594.5
594.5	594.5	594.5	594.4	594.4	594.4	594.4	594.4	594.4	594.3

PEAK OUTFLOW IS 7722. AT TIME 16.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	7722.	2422.	731.	702.	210631.
CMS	219.	69.	21.	20.	5964.
INCHES		22.09	26.68	26.68	26.68
MM		561.16	677.67	677.67	677.67
AC-FT		1201.	1451.	1451.	1451.
THOUS CU M		1482.	1789.	1789.	1789.

ONE-HALF PMF FLOOD ROUTING

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                                   STATION      6, PLAN 1, RATIO 2

                                  END-OF-PERIOD HYDROGRAPH ORDINATES

                                              OUTFLOW
        0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
        0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
        0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
        0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
        0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
        0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
        0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
        1.        1.        1.        1.        2.        2.        3.        5.        6.        8.
        9.       11.       12.       14.       16.       16.       16.       16.       16.       16.
       16.       16.       16.       16.       16.       16.       16.       16.       16.       16.
       16.       16.       16.       16.       16.       16.       16.       16.       16.       16.
       16.       16.       16.       16.       16.       16.       16.       16.       16.       16.
       16.       16.       16.       16.       16.       16.       16.       16.       16.       16.
       16.       16.       16.       16.       16.       16.       16.       16.       16.       16.
       16.       16.       16.       16.       16.       16.       16.       16.       16.       16.
       35.       61.       87.      112.      136.      160.      183.      205.      226.      249.
      272.      295.      318.      341.      363.      384.      404.      424.      443.      461.
      480.      517.      557.      597.      635.      672.      707.      739.      769.      797.
      824.      848.      868.      883.      901.      931.      981.     1077.     1274.     1711.
     2163.     2445.     2551.     2560.     2511.     2418.     2298.     2175.     2057.     1947.
     1847.     1758.     1679.     1609.     1548.     1493.     1442.     1390.     1342.     1312.
     1281.     1252.     1225.     1199.     1175.     1153.     1132.     1112.     1088.     1052.
     1004.      949.      892.      837.      784.      734.      687.      643.      602.      564.
      528.      495.      471.      456.      441.      427.      413.      400.      387.      375.
      363.      352.      341.      330.      320.      310.      301.      292.      283.      275.
      267.      259.      251.      244.      237.      230.      224.      218.      212.      206.
      200.      195.      190.      185.      180.      176.      171.      167.      163.      159.
      155.      151.      148.      145.      141.      138.      135.      132.      129.      127.
      124.      122.      119.      117.      115.      112.      110.      108.      106.      105.
      103.      100.       97.       94.       91.       88.       84.       81.       78.       75.

                                              STORAGE
      528.      528.      528.      528.      528.      528.      528.      528.      528.      528.
      528.      528.      528.      528.      528.      528.      528.      528.      528.      528.
      528.      528.      528.      528.      528.      528.      528.      528.      528.      528.
      528.      528.      528.      528.      528.      528.      528.      528.      528.      528.
      528.      528.      528.      528.      528.      528.      528.      528.      528.      528.
      528.      528.      528.      528.      528.      528.      528.      528.      528.      528.
      528.      528.      528.      528.      528.      528.      528.      528.      528.      528.
      529.      529.      529.      529.      530.      530.      531.      533.      534.      536.
      537.      539.      540.      542.      544.      545.      547.      548.      550.      551.
      553.      554.      556.      558.      559.      561.      562.      564.      565.      567.
      569.      570.      572.      573.      575.      576.      578.      579.      581.      583.
      584.      586.      587.      589.      590.      592.      594.      595.      597.      598.
      600.      601.      603.      604.      606.      608.      609.      611.      612.      614.
      615.      617.      618.      620.      622.      623.      625.      626.      628.      629.
      631.      632.      634.      635.      637.      639.      640.      643.      647.      652.
      656.      661.      666.      670.      675.      679.      683.      687.      691.      695.
      700.      704.      708.      712.      716.      720.      724.      727.      731.      734.
      737.      741.      745.      749.      752.      756.      759.      762.      765.      768.
      770.      772.      774.      776.      777.      780.      785.      794.      813.      839.
      864.      879.      886.      886.      883.      878.      871.      865.      858.      852.
      847.      842.      838.      834.      831.      828.      825.      822.      819.      816.
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   813.      811.      808.      806.      803.      801.      799.      797.      795.      792.
   787.      782.      777.      771.      766.      762.      757.      753.      749.      745.
   742.      739.      736.      733.      730.      728.      725.      723.      721.      718.
   716.      714.      712.      710.      708.      707.      705.      703.      702.      700.
   699.      697.      696.      695.      693.      692.      691.      690.      689.      688.
   687.      686.      685.      684.      683.      682.      681.      681.      680.      679.
   678.      678.      677.      676.      676.      675.      675.      674.      674.      673.
   673.      672.      672.      671.      671.      671.      670.      670.      669.      669.
   669.      668.      668.      667.      667.      666.      665.      665.      664.      664.

                                             STAGE
  590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0
  590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0
  590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0
  590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0
  590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0
  590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0
  590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0     590.0
  590.0     590.1     590.1     590.1     590.1     590.1     590.2     590.3     590.4     590.5
  590.6     590.7     590.8     590.9     591.0     591.1     591.2     591.3     591.4     591.5
  591.6     591.7     591.8     591.9     591.9     592.0     592.0     592.1     592.1     592.2
  592.2     592.2     592.3     592.3     592.3     592.4     592.4     592.4     592.5     592.5
  592.5     592.6     592.6     592.6     592.7     592.7     592.7     592.8     592.8     592.8
  592.9     592.9     592.9     593.0     593.0     593.0     593.1     593.1     593.1     593.2
  593.2     593.2     593.3     593.3     593.3     593.4     593.4     593.4     593.5     593.5
  593.5     593.6     593.6     593.6     593.7     593.7     593.7     593.8     593.9     594.0
  594.1     594.1     594.2     594.3     594.4     594.5     594.5     594.6     594.7     594.7
  594.8     594.9     595.0     595.0     595.1     595.2     595.2     595.3     595.4     595.4
  595.5     595.5     595.6     595.7     595.7     595.8     595.9     595.9     596.0     596.0
  596.1     596.1     596.1     596.2     596.2     596.2     596.3     596.5     596.8     597.3
  597.7     598.0     598.1     598.1     598.0     597.9     597.8     597.7     597.6     597.5
  597.4     597.3     597.2     597.2     597.1     597.1     597.0     597.0     596.9     596.9
  596.8     596.8     596.7     596.7     596.6     596.6     596.6     596.5     596.5     596.4
  596.4     596.3     596.2     596.1     596.0     595.9     595.8     595.8     595.7     595.6
  595.6     595.5     595.5     595.4     595.4     595.3     595.3     595.2     595.2     595.1
  595.1     595.1     595.0     595.0     595.0     594.9     594.9     594.9     594.9     594.8
  594.8     594.8     594.8     594.7     594.7     594.7     594.7     594.6     594.6     594.6
  594.6     594.6     594.6     594.5     594.5     594.5     594.5     594.5     594.5     594.5
  594.4     594.4     594.4     594.4     594.4     594.4     594.4     594.4     594.4     594.4
  594.3     594.3     594.3     594.3     594.3     594.3     594.3     594.3     594.3     594.3
  594.3     594.3     594.3     594.2     594.2     594.2     594.2     594.2     594.2     594.2

PEAK OUTFLOW IS     2560. AT TIME  16.17 HOURS

                            PEAK    6-HOUR    24-HOUR    72-HOUR   TOTAL VOLUME
                   CFS     2560.     1112.       334.       320.         96057.
                   CMS       72.       31.         9.         9.          2720.
                INCHES               10.14      12.17      12.17          12.17
                    MM              257.49     309.04     309.04         309.04
                 AC-FT                551.       662.       662.           662.
            THOUS CU M                680.       816.       816.           816.
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SUMMARY OF PMF AND ONE-HALF PMF FLOOD ROUTING

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00	 RATIO 2 .50
HYDROGRAPH AT	6	1.02 (2.64)	1	11738. (332.38)(	5849. 166.19)(
ROUTED TO	6	1.02 (2.64)	1	7722. (218.66)(	2560. 72.49)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	590.00	590.00	598.00
STORAGE	528.	528.	881.
OUTFLOW	0.	0.	2879.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	599.80	1.80	1006.	7722.	1.75	16.00	0.00
.50	598.08	.08	886.	2560.	.25	16.17	0.00

PERCENT OF PMF FLOOD ROUTING
EQUAL TO SPILLWAY CAPACITY

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT 6
ROUTE HYDROGRAPH TO 6
END OF NETWORK

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  21 AUG 78
**********

RUN DATE= 78/12/19.
     TIME= 08.53.19.
```

DAM SAFETY INSPECTION - MISSOURI
EWING LAKE DAM
PERCENT OF PMF DETERMINATION AND ROUTING

JOB SPECIFICATION

NQ	NMR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	5	0	0	0	0	0	4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1

RTIOS=	.45	.46	.47	.48	.49	.50	.51	.52	.53

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INPUT INDEX PRECIPITATION AND RATIOS, INPUT SCS UNIT H

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

INFLG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	-1	1.02	0.00	1.02	1.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.00	100.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	.85	.07	0.00	0.00

RECESSION DATA

STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

END-OF-PERIOD FLOW

MO,DA	HR,MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO,DA	HR,MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	31.20	29.04	2.16	231597.
										(792.)(738.)(55.)(6558.10)			

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THROUGH EWING LAKE DAM

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-590.	-1

STAGE	590.0	591.0	592.0	593.0	595.5	596.9	598.4	599.8	601.1	602.4
FLOW	0.	16.	16.	16.	479.	1350.	2859.	7587.	13951.	21695.
CAPACITY=	0.	569.	653.	881.	1020.	3081.				
ELEVATION=	557.	592.	594.	598.	600.	620.				

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
590.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
598.0	0.0	0.0	0.

PEAK OUTFLOW IS 2228. AT TIME 16.17 HOURS

PEAK OUTFLOW IS 8298. AT TIME 16.17 HOURS

PEAK OUTFLOW IS 2367. AT TIME 16.17 HOURS

PEAK OUTFLOW IS 2437. AT TIME 16.17 HOURS

PEAK OUTFLOW IS 2502. AT TIME 16.17 HOURS

PEAK OUTFLOW IS 2560. AT TIME 16.17 HOURS

PEAK OUTFLOW IS 2618. AT TIME 16.17 HOURS

PEAK OUTFLOW IS 2677. AT TIME 16.17 HOURS

PEAK OUTFLOW IS 2735. AT TIME 16.17 HOURS

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PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS								
				RATIO 1 .85	RATIO 2 .86	RATIO 3 .87	RATIO 4 .88	RATIO 5 .89	RATIO 6 .90	RATIO 7 .91	RATIO 8 .92	RATIO 9 .93
HYDROGRAPH AT	A	1.02	1	5282.	5399.	5517.	5634.	5752.	5869.	5986.	6104.	6221.
		(2.64)		(149.57)(	152.90)(	156.22)(	159.54)(	162.87)(	166.19)(	169.52)(	172.84)(	176.16)
ROUTED TO	A	1.02	1	2226.	2298.	2367.	2437.	2502.	2560.	2618.	2677.	2735.
		(2.64)		(63.08)(	65.06)(	67.04)(	69.00)(	70.85)(	72.49)(	74.15)(	75.80)(	77.44)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	590.00	590.00	598.00
STORAGE	528.	528.	881.
OUTFLOW	0.	0.	2479.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.45	597.76	0.00	867.	2228.	0.00	16.17	0.00
.46	597.83	0.00	871.	2298.	0.00	16.17	0.00
.47	597.89	0.00	875.	2367.	0.00	16.17	0.00
.48	597.96	0.00	879.	2437.	0.00	16.17	0.00
.49	598.02	.02	883.	2502.	.17	16.17	0.00
.50	598.08	.08	886.	2560.	.25	16.17	0.00
.51	598.13	.13	890.	2618.	.42	16.17	0.00
.52	598.19	.19	894.	2677.	.42	16.17	0.00
.53	598.24	.24	898.	2735.	.50	16.17	0.00


DATE
ILME